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ABSTRACT

Current reform in mathematics and science education advocates the integration of science and mathematics teaching and learning as a means of improving achievement and attitudes within both disciplines. This bibliography is a collaborative effort involving the ERIC Clearinghouse for Science, Mathematics, and Environmental Education; the National Center for Science Teaching and Learning; the National Science Foundation; and the School Science and Mathematics Association. It is prepared for classroom teachers, teacher educators, curriculum reformers and developers, and educational researchers interested in the integration of science and mathematics teaching and learning. The bibliography of 555 citations is divided into five sections. The "Curriculum Literature" section lists 84 citations dealing with what students are taught. The "Instruction Literature" section lists 251 citations related to how the students are taught. The "Research Literature" section includes 41 citations of research documents from both qualitative and quantitative perspectives of inquiry and reviews of research. The "Curriculum-Instruction" section of 166 citations is used to classify curriculum programs that include instructional activities. The "Curriculum-Evaluation" section of 13 citations is used to classify curriculum programs that include evaluation of curriculum programs. The introduction compares the different sections by number and content and discusses the nature and significance of that content. (MDH)

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Integrating Science and Mathematics in Teaching and Learning

A Bibliography

Donna F. Berlin

National Center for Science Teaching and Learning
The Ohio State University
August 1991

School Science and Mathematics Association
Topics for Teachers Series Number 6

ERIC Clearinghouse for Science, Mathematics and Environmental Education
The Ohio State University
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Preface

This bibliography represents a pioneering attempt to identify and categorize the substantive literature related to the integration of science and mathematics teaching and learning. It is a timely document intended for classroom teachers, teacher educators, curriculum specialists, and researchers who are interested in studying or promoting integration of science and mathematics in schools. It is also intended that this bibliography will be periodically updated as theory and practice related to integration evolve.

This document is the product of a collaborative effort involving the ERIC Clearinghouse for Science, Mathematics, and Environmental Education; the National Center for Science Teaching and Learning; the National Science Foundation; and the School Science and Mathematics Association. These agencies have joined in developing this bibliography to aid educators in the ongoing quest to promote increased understanding of the connections among science, mathematics, and technology in our everyday affairs. A fundamental idea of this quest is that the disciplines of science and mathematics share a common core, the search for understanding through inquiry.

Readers are invited to submit recommendations and comments regarding this bibliography to the ERIC Clearinghouse for Science, Mathematics, and Environmental Education (ERIC/CSMEE), Room 310, 1200 Chambers Road, Columbus, OH 43212. With your help this bibliography will serve as a vehicle to advance scholarship in the area of integrating science and mathematics teaching and learning.

David L. Haury, Director
ERIC/CSMEE

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Introduction

As one goal in the *America 2000* education strategy, U.S. President George Bush has proclaimed that, "U. S. students will be first in the world in science and mathematics achievement." (Bush, 1990, p. 9) Current literature related to reform in science and mathematics education endorses the integration of science and mathematics teaching and learning as a means of improving achievement and attitudes within both disciplines.

The significance and timeliness of this compilation of the literature related to integrated science and mathematics teaching and learning is established by the following excerpts from five recent education reform documents. These documents address the interrelated nature of science and mathematics along with implications for curricula and instructional practice.

Science for all Americans suggests a symbiotic relationship between science and mathematics:

> The alliance between science and mathematics has a long history, dating back centuries. Science provides mathematics with interesting problems to investigate, and mathematics provides science with powerful tools to use in analyzing data....Science and mathematics are both trying to discover general patterns and relationships, and in this sense they are part of the same endeavor. (Rutherford & Ahlgren, 1990, pp. 16-17)

In *Project 2061. Science for all Americans. Summary* (American Association for the Advancement of Science, 1989), this perspective is translated into curricula recommendations:

> The national council's recommendations include some topics that are not common in school curricula. Among those topics are the nature of the scientific enterprise, and how science, mathematics, and technology relate to one another and to the social system in general. (p. 5) The school curricula—from kindergarten through twelfth grade —[among other things]... must be changed...to weaken or eliminate rigid disciplinary boundaries, to pay more attention to the connections among science, mathematics, and technology... (p. 10)

A similar position is reflected in the mathematics education reform document, *Reshaping School Mathematics. A Philosophy and Framework for Curriculum* (National Research Council, 1990):

> Since mathematics is both the language of science and a science of patterns, the special links between mathematics and science are far more than just those between theory and applications. The methodology of mathematical inquiry

> shares with the scientific method a focus on exploration, investigation, conjecture, evidence, and reasoning. Firmer school ties between science and mathematics should especially help students' grasp of both fields. (pp. 44-45)

In *Everybody Counts. A Report to the Nation on the Future of Mathematics Education* (National Research Council, 1989), the curricular relationship between science and mathematics is discussed:

> Now much more than arithmetic and geometry, mathematics today is a diverse discipline that deals with data, measurements, and observations from science; with inference, deduction, and proof; and with mathematical models of natural phenomena, of human behavior, and of social systems. (p. 31)

Recommendations for instructional practice related to integrated science and mathematics teaching permeate the National Council of Teachers of Mathematics' *Curriculum and Evaluation Standards for School Mathematics* (1989). For grades K-4, 5-8, and 9-12 respectively, the standards recommend "instructional practices characterized by content integration" (p.20), "connecting mathematics to other subjects and to the world outside the classroom" (p.70), and "the use of real-world problems to motivate and apply theory" (p.126).

Philosophically and theoretically, there is strong support for the integration of science and mathematics teaching and learning as a way to improve and enrich the science and mathematics learning experiences. This bibliography has been prepared for classroom teachers, teacher educators, curriculum reformers and developers, and educational researchers interested in the exploration of the topic of integrated science and mathematics teaching and learning.

This bibliography of integrated science and mathematics teaching and learning literature has been divided into five sections: Curriculum, Instruction, Research, Curriculum—Instruction, and Curriculum—Evaluation. A narrow definition of curriculum has been used. The curriculum relates to intended learnings or the outcomes of being educated. Citations in the Curriculum section primarily deal with the content in a course or group of courses or simply put "what students are taught". Instruction is the process of implementing the curriculum. It refers to the structuring of the learning environment to coordinate elements of time, space, materials, equipment, and personnel. Simply put, citations in the Instruction section primarily relate to "how students are taught". While it is recognized that the instruction literature must initially deal with the curriculum, those documents that have been placed in this category primarily deal with the instructional elements. The Research section of the bibliography includes research documents that generate new knowledge and understandings from both qualitative and quantitative perspectives of inquiry. The Research section also includes reviews of research. Two additional sections were used in order to classify curriculum programs that include instructional activities (Curriculum—Instruction section) and evaluation of curriculum programs (Curriculum—Evaluation section). It should be noted that while most of the citations can be distinctly placed in one of the bibliography sections, there are some that cannot, and these placement decisions were based upon the primary focus

of the document.

Although there are 555 citations in the bibliography, this listing is not intended to be exhaustive. The editor apologizes to any author whose work in this area has been inadvertently omitted, and communication as to any omissions would be appreciated. This bibliography is not intended as a final product, but will be periodically updated. Copies of the documents referenced in the bibliography are housed in the library of the National Center for Science Teaching and Learning at The Ohio State University, Columbus, Ohio.

The topic of integrated science and mathematics teaching and learning is not new. The earliest document referenced in the bibliography was published in 1905 in *School Science and Mathematics*. At the turn of the century, numerous articles appeared in this same journal published by the Central Association of Science and Mathematics Teachers (CASMT). In 1970, this association was renamed the School Science and Mathematics Association (SSMA) and their journal, *School Science and Mathematics*, continues to be a principal source for integrated science and mathematics articles. National funding agencies have also been involved in integration efforts. The National Science Foundation has funded various curriculum projects and sponsored two national level integration conferences: The Cambridge Conference on the Correlation of Science and Mathematics in the Schools (1967), and most recently The Wingspread Conference for A Network for Integrated Science and Mathematics Teaching and Learning (1991).

A cursory look at the bibliography reveals that there is a plethora of terms being used to refer to *integration* (e.g., connections, cooperation, coordinated, correlated, cross-disciplinary, fused, interactions, interdependent, interdisciplinary, interrelated, linked, multidisciplinary, transdisciplinary, and unified). These terms represent various degrees of integration including mathematics taught as a prerequisite tool for science, mathematics applied to science problems, science phenomena translated into mathematical terms, and science and mathematics taught in concert in a real-world, problem-solving context.

A comparison of the separate sections of the bibliography indicates that the documents related to instruction permeate the literature. Specifically, there are 251 documents in the Instruction section as compared to 84 in the Curriculum section, 41 in the Research section, 166 in the Curriculum—Instruction section, and 13 in the Curriculum—Evaluation section. Science-related areas such as consumer education, energy education, engineering, environmental education, marine education, nutrition education, science career education, technical education, and vocational education naturally provide experiences and activities related to both science and mathematics. The integration of science and mathematics often develops from the nature of the topics rather than by thoughtful intent. Consequently, there are many instructional documents in the bibliography that are associated with these areas of science education.

The instruction literature was reviewed in terms of science concepts and processes, mathematics concepts and skills, and grade level distribution. Analysis of this literature reveals that most of the documents are basically science instructional activities or lessons which include mathematics-related concepts. The science processes of classifying, collecting and organizing data, communicating, controlling variables, developing models, experimenting, inferring, interpreting data, measuring, observing,

predicting, and space-time relationships were most frequently cited in the instruction literature. The most frequent mathematics concepts/skills mentioned or implied include: angular measurement, estimation, formulas and equations, fractions, function, geometry, graphs, modeling, patterns, percentage, probability and statistics, problem solving, ratio and proportion, and variable. The mathematics concepts are sometimes, but not often, recognized or stated as objectives in the activities. These same science and mathematics concepts/processes/skills are most often suggested as appropriate content for integrated science and mathematics curricula and are more frequently associated with the physical sciences as compared to the life and earth sciences. (See the Curriculum section.) Most of the activities/lessons are designed for upper elementary and middle school grades (3 through 8). Surprisingly, there are about the same number of instructional documents related to the primary grades (kindergarten through 2) as compared to the secondary school grades (9 through 12). One would have hypothesized more instructional activities designed for the early grades as these classrooms are often characterized as self-contained, holistic, integrated learning environments. There are very few documents related to post-secondary instruction.

Some notable curriculum—instructional programs designed as total programs or as supplements to the established curricula appear in the literature. Some were developed in the 1970s, such as the Minnesota Mathematics and Science Teaching Project (MINNEMAST) and Unified Science and Mathematics for Elementary Schools (USMES). During the last five years, there has been a resurgence in the development of programs that integrate science and mathematics. Recent programs include Activities Integrating Math and Science (AIMS), Great Explorations in Math and Science (GEMS), the Jasper Series, Teaching Integrated Mathematics and Science (TIMS), The Voyage of the Mimi, and the Second Voyage of the Mimi. Inspection of the Curriculum—Evaluation section, reveals that there is a critical need for more attention to the assessment of the effects of these programs as related to student science and mathematics achievement and attitude.

The bibliography reveals a profound lack of research documents. Out of 555 citations, only 41 or 7% relate to research. Some of the research documents are only tangentially related to integrated science and mathematics teaching and learning. A number of research studies relate conservation and seriation skills, graphing ability, problem solving ability, proportional reasoning, and spatial ability to mathematics and/or science achievement. These studies relate specific abilities to both science and mathematics achievement and consequently infer a rationale for the integration of science and mathematics education. As previously noted, the terminology and definition of integration is not at all consistent within the literature which precludes reliable and valid comparisons among research studies. Furthermore, many of the research studies were designed only to examine the effect of integration on achievement or attitude in science or mathematics, but not the effect on achievement and attitude related to both disciplines. There is clearly a need for careful conceptualization and additional research on integrated science and mathematics teaching and learning.

It is hoped that this bibliography will generate additional thought and research in order to gain a better understanding of integrated science and mathematics teaching

and learning and possibilities for improving and enriching the teaching and learning of these two disciplines. Some areas for exploration include: the development of a hierarchical arrangement or continuum for the definitions of integration, the development of a theoretical and research-based rationale for integrated teaching and learning of science and mathematics, the specification of guidelines for infusion of integrated teaching and learning of science and mathematics into school practice, and the identification of high priority research questions related to integrated teaching and learning of science and mathematics. The expressed goals and objectives of the National Center for Science Teaching and Learning (NCSTL) Focus Area 5: Integration Across Content Areas reflect an effort to spearhead the exploration. NCSTL, funded by the Office of Educational Research and Improvement, has been instrumental in and supportive of The Wingspread Conference and the publication of this bibliography. Future projects include dissemination of the Instruction section of this bibliography as a computer database, publication of the Wingspread Conference Proceedings, Literature Synthesis Reports, an Integration Writers Conference, and the coordination of various integration research projects. As coordinator of the integration focus area, it is my intention to establish and promote a national, coordinated effort to explore the role of integrated science and mathematics teaching and learning related to today's science and mathematics education reform movements.

References

American Association for the Advancement of Science. (1989). *Project 2061. Science for all Americans. Summary.* Washington, DC: Author.

Bush, G. (1990). *America 2000. An education strategy.* Washington, DC: U.S. Department of Education.

National Council of Teachers of Mathematics. Commission on Standards for School Mathematics. (1989, March). *Curriculum and evaluation standards for school mathematics.* Reston, VA: National Council of Teachers of Mathematics.

National Research Council. (1989). *Everybody counts. A report to the nation on the future of mathematics education.* Washington, DC: National Academy Press.

National Research Council. (1990). *Reshaping school mathematics. A philosophy and framework for curriculum.* Washington, DC: National Academy Press.

Rutherford, F. J., & Ahlgren, A. (1990). *Science for all Americans.* New York: Oxford Press.

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Curriculum

Almy, M. (1966). *Young children's thinking*. New York: Teacher's College Press, Columbia University.

American Association for the Advancement of Science Project 2061. (1989). *Science for all Americans: A project 2061 report on literacy goals in science, mathematics and technology*. Washington, DC: American Association for the Advancement of Science. (ERIC Document Reproduction Service No. ED 309 059)

Artigue, M. (1988, August). *Obstacles as objects of comparative studies in mathematics and physics*. Paper presented at the meeting of The Sixth International Congress on Mathematical Education, Budapest, Hungary.

Bacon, C., & Webb, N. (1975). Co-operation between science and mathematics departments. *Mathematics in School*, *4*(6), 6-9.

Baker, J. R. (1975). Modern mathematics and the teaching of science: Some questions and answers. *International Journal of Mathematical Education in Science Technology*, *6*(1), 83-96.

Berlin, D. F. (1990, March). Science and mathematics integration: Current status and future directions. *School Science and Mathematics*, *90*(3), 254-257.

Berlin, D. F., & Jones, S. (1987, April). The integration of science and mathematics: Early childhood and middle school levels. *School Science and Mathematics*, *87*(4), 271-273.

Bishop, F. L. (1905, March). Progress in the correlation of physics and mathematics. *School Science and Mathematics*, *5*(3), 152-159.

Boeck, C. H. (1972, January). Science and mathematics: Siblings, not strangers. Establishing the relationship. *School Science and Mathematics*, *72*(1), 35-38.

Boehm, L. (1961, April). Exploring children's thinking. *Elementary School Journal*, *61*, 363-373.

Breslich, E. R. (1936, January). Integration of secondary-school mathematics and science. *School Science and Mathematics*, *36*(1), 58-67.

Briers, G. E., Dayberry, D. T., & Reap, M. (1986). *Identification of math and science concepts, skills, and experiences provided in vocational agriculture in Texas*.

Austin, TX: Texas Education Agency, Department of Occupational Education and Technology. (ERIC Document Reproduction Service No. ED 281 035)

Brogan, W. (1939, February). Science and arithmetic in the elementary school curriculum. *School Science and Mathematics, 39*(2), 149-155.

Bubb, F. W. (1937, January). On the role of geometry in science. *School Science and Mathematics, 37*(1), 55-71.

Calandra, A. (1959, May). The role of mathematics in an integrated 9th grade science-mathematics course. *The American Mathematical Monthly, 66*(5), 415-517.

Capie, W., & Fox, F. M. (1975). *Reflections on science education. 1976 AETS yearbook.* Columbus, OH: The Ohio State University, ERIC Clearinghouse for Science, Mathematics, and Environmental Education. (ERIC Document Reproduction Service No. ED 126 253)

Carnahan, W. H. (1941, February). Some desirable curriculum adjustments in science and mathematics. *School Science and Mathematics, 41*(2), 103-114.

Carpenter, R. E. (1962, May). How much mathematics should be required and used in high school physics? *School Science and Mathematics, 62*(5), 374-378.

Carter, M. A. (1978, March). A view from the top: Elementary science and the three R's. *The American Biology Teacher, 40*(3), 146-147, 163.

Clark, S. M. (1979, March). Learning together - An integrated chemistry and mathematics program. *School Science and Mathematics, 79*(3), 243-247.

Cohn, S. J. (1979, October). Searching for scientifically talented youth? *Science and Children, 17*(2), 18-19.

Cooney, T. J., & Henderson, K. B. (1972, May). Structuring knowledge in mathematics and science. *School Science and Mathematics, 72*(5), 425-430.

Creating an integrated curriculum — The 'higher' in higher education. 1981 current issues in high education, No. 2. (1981). Washington, DC: American Association for Higher Education. (ERIC Document Reproduction Service No. ED 213 324)

Disinger, J. F. (1987). *Environmental education in K-12 curricula.* (ERIC/SMEAC Environmental Information Bulletin No. 2, 1987). Columbus, OH: ERIC Clearinghouse for Science, Mathematics, and Environmental Education. (ERIC Document Reproduction Service No. ED 293 718)

Disinger, J. F. (1987). *Trends and issues in environmental education: EE in school curricula. Reports of a symposium and a survey. Environmental education information reports*. Columbus, OH: ERIC Clearinghouse for Science, Mathematics, and Environmental Education. (ERIC Document Reproduction Service No. ED 292 608)

Fensham, P. F. (1979, July-September). Co-operation between cousins: Science and mathematics educators look at what is possible and what has proved not possible. *European Journal of Science Education, 1*(3), 347-352.

Final Report of Cambridge Conference on School Mathematics, January 1962 - August 1970. (1970). Newton, MA: Education Development Center. (ERIC Document Reproduction Service No. ED 188 904)

Flegg, H. G. (1974). The mathematical education of scientists and technologists—A personal view. *International Journal of Mathematical Education in Science and Technology, 5*(1), 65-74.

Flemming, W. (Ed.). (1975, February). Mathematical Association in conjunction with the University of Leichester School of Education: Modern mathematics and the teaching of science. *International Journal of Mathematical Education in Science Technology. 6*(1), 89-91.

Gallagher, J. J. (1979, November). Basic skills common to science and mathematics. *School Science and Mathematics, 79*(7), 555-565.

Georges, J. S. (1926, October). Functional relations and mathematical training. *School Science and Mathematics, 26*(7), 689-704.

Goodrich, M. T. (1935, January). Algebra as a medium for the interpretation and control of nature. *School Science and Mathematics, 35*(1), 16-17.

Green, R., & Brown, J. W. (1976). *Recommendations for the improvement of science and mathematics education for American Indians*. Washington, DC: American Association for the Advancement of Science. (ERIC Document Reproduction Service No. ED 149 896)

Grove, E. L., & Grove, E. L. (1952, June). An experiment in the integration of mathematics and science. *School Science and Mathematics, 52*(6), 467-470.

Haas, J. D. (1975, January). For lack of a loom: Problems in integrating knowledge. *School Science and Mathematics, 75*(1), 4-14.

Haywood County Consolidated Schools. (1985). *Haywood County's vocational-math-science curriculum alignment project. Project orientation manual.* Raleigh, NC: North Carolina State Department of Public Instruction, Division of Vocational Education. (ERIC Document Reproduction Service No. ED 269 558)

Holford, D. G. (1975). The chemist's viewpoint. Mathematics in science teaching: A review of current literature. *International Journal of Mathematical Education in Science Technology*, *6*(1), 101-103.

House, P. A. (1986, October). Now more than ever: The alliance of science and mathematics. *School Science and Mathematics*, *86*(6), 456-460.

House, P. A. (1988, December). Components of success in mathematics and science. *School Science and Mathematics*, *88*(8), 632-641.

House, P. A. (1990, October). Mathematical connections: A long-overdue standard. *School Science and Mathematics*, *90*(6), 517-527.

Ingraham, M. H. (1945, February). Mathematics and science in a liberal education. *School Science and Mathematics*, *45*(2), 128-135.

Jackson, G. (1972). Physics and engineering. *Physics Education*, *7*(2), 74-77.

James, R. K., & Kurtz, V. R. (1985). *Science and mathematics education for the year 2000 and beyond.* (School Science and Mathematics Association Topics for Teacher Series Number 4). Bowling Green, OH: School Science and Mathematics Association.

Karpinski, L. C. (1929, February). Mathematics and the progress of science. *School Science and Mathematics*, *29*(2), 126-132.

Kinney, J. M. (1930, March). Cooperation in the teaching of science and mathematics. *School Science and Mathematics*, *30*(3), 233-237.

Kline, M. (1966, April). A proposal for the high school mathematics curriculum. *The Mathematics Teacher*, *59*(4), 322-330.

Kochnower, W. (1958, June). An integrated mathematics-science secondary school program. *High Points*, *40*(6), 39-50.

Kuliman, D. E. (1966, October). Correlation of mathematics and science teaching. *School Science and Mathematics*, *66*(6), 645-649.

Laper, L. M. (1961, October). How to improve science teaching through mathematics. *School Science and Mathematics*, *61*(7), 487-488.

Malvern, D. (1975). Synchronizing mathematics and physics in the sixth form. *Physics Education*, *10*(5), 344-349.

McGarry, T. P. (1986, November). Integrating learning for young children. *Educational Leadership*, *44*(3), 64-66.

Milson, J. L., & Ball, S. E. (1986, October). Enhancement of learning through integrating science and mathematics. *School Science and Mathematics*, *86*(6), 489-493.

Mock, G. D. (1963, March). The Perry movement. *The Mathematics Teacher*, *56*(6), 130-133.

Moore, E. H. (1970). On the foundations of mathematics. In J. K. Bidwell & R. G. Clason (Eds.), *Readings in the history of mathematics education* (pp. 246-255). Washington, DC: National Council of Teachers of Mathematics. (ERIC Document Reproduction Service No. ED 038 316)

National Council of Teachers of Mathematics. Commission on Standards for School Mathematics. (1989, March). *Curriculum and evaluation standards for school mathematics*. Reston, VA: National Council of Teachers of Mathematics.

National Research Council. (1989). *Everybody counts. A report to the nation on the future of mathematics education.* Washington, DC: National Academy Press. (ERIC Document Reproduction Service No. ED 309 938)

National Research Council. (1990). *Reshaping school mathematics. A philosophy and framework for curriculum.* Washington, DC: National Academy Press. (ERIC Document Reproduction Service No. ED 319 588)

Nelson, P. A. (1962, December). Precision in science and arithmetic in the elementary school. *School Science and Mathematics*, *62*(9), 639-644.

Ost, D. H. (1975, January). Changing curriculum patterns in science, mathematics, and social studies. *School Science and Mathematics*, *75*(1), 48-52.

Ost, D. H. (1987, May). Models, modeling, and the teaching of science and mathematics. *School Science and Mathematics*, *87*(5), 363-370.

Pinsky, M., & Speed, R. C. (1978, May). Mathematics in the integrated science program at Northwestern University. *The American Mathematical Monthly*, *85*(5), 380-383.

Ray, A. K. (1974, April-June). Science policy and its implications in mathematical education in Canadian conditions. *International Journal of Mathematical Education in Science Technology*, *5*(2), 219-227.

Reed, J. A. (1971, November). Integrating the teaching of science and mathematics in the elementary school. *School Science and Mathematics*, *71*(8), 725-730.

Reeve, W. D. (Ed.). (1931). *Mathematics in modern life. National Council of Teachers of Mathematics, Yearbook 6.* Reston, VA: The National Council of Teachers of Mathematics. (ERIC Document Services No. ED 096 167)

Reinstein, W. J. (1990, March). When physics and calculus meet. *The Science Teacher*, *57*(3), 43-44.

Resnick, L. B. (1983, April 29). Mathematics and science learning: A new conception. *Science*, *220*, 477-478.

Royal Society - Institute of Biology. Biological Education Committee. (1975, February). Report of the working party on mathematics for biologists. *International Journal of Mathematical Education in Science and Technology*, *6*(1), 123-135.

Rutherford, F. J., & Ahlgren, A. (1990). *Science for all Americans*. New York: Oxford University Press.

Schaaf, W. L. (1965, October). Scientific concepts in the junior high school mathematics curriculum. *School Science and Mathematics*, *65*(7), 614-625.

Schlenker, R. M., & Perry, C. M. (1981, October). Scientific concepts through moving air masses. *The Science Teacher*, *48*(7), 42-45.

Selby, C. C. (1988, February). Integrated mathematics, science and technology education. Opening doors and opening minds. *The Technology Teacher*, *47*(5), 3-5.

Smith, D. E. (1905, March). Movements in mathematical teaching. *School Science and Mathematics*, *5*(3), 135-139.

Steen, L. A. (1987, July 17). Mathematics education: A predictor of scientific competitiveness. *Science*, *237*, 251-252, 302.

Steiner, H. G. (1983, December). *Mathematics and experimental sciences in the FRG-upper secondary schools. Occasional paper 40.* Paper presented at the meeting

of The International Seminar on Insegnamento della mathematica e delle scienze sperimentali nella scuola secondaria superiore, Venice, Italy.

Steiner, H. G. (1988, August). *Needed cooperation between science education and mathematics education*. Paper presented at the meeting of The Sixth International Congress on Mathematical Education, Budapest, Hungary.

Steinheimer, M. (1984, November). Webbing an integrated science program. *Science Scope*, *8*(2), 10-11.

Stendler, C. B. (1961, December). Cognitive development in children and readiness for high school physics. *American Journal of Physics*, *29*(12), 832-835.

Stendler, C. B. (1962, September). Elementary teaching and the Piagetian theory. *The Science Teacher*, *29*(5), 34-35, 37, 39.

Stone, M. H. (1961). Reform in school mathematics. In *New Thinking in School Mathematics* (pp. 14-29). Washington, DC: Organization for European Economic Co-operation.

Tomes, D. (1972). Physics and mathematics. *Physics Education*, *7*(2), 78-79.

Tomley, D. (1975, February). Mathematics and biology teaching. *International Journal of Mathematical Education in Science and Technology*, *6*(1), 97-99.

Voss, B. E. (1980, November). Objectives for middle school science. *School Science and Mathematics*, *80*(7), 573-576.

Wilder, R. L. (1973, December). Mathematics and its relations to other disciplines. *Mathematics Teacher*, *66*(8), 679-685.

Wright, P. G. (1980, July). Modern mathematics and chemistry — Some benefits and drawbacks. *Education in Chemistry*, *17*(4), 113-114.

Instruction

Abbondanzio, R. (1990, November). Cassette kinematics. A reel-world experiment. *The Science Teacher*, *57*(8), 23-25.

Activities for studying heavenly bodies. (Outdoor education series. Bulletin No. 247-M). (1979). Rockville, MD: Montgomery County Public Schools. (ERIC Document Reproduction Service No. ED 242 474)

Alberti, D., & Laycock, M. (1975). *The correlation of activity-centered science and mathematics* (2nd ed.). Hayward, CA: Activity Resources Company.

Allen, R. F. (Ed.). (1983). *101 ways to teach about exponential growth and its consequences.* Sebring, FL: Tri-County Teacher Education Center. (ERIC Document Reproduction Service No. ED 225 856)

Austin, J. D. (1990, March). Optimal football kicks. *School Science and Mathematics*, *90*(3), 198-203.

Bajpai, A. C., Mustoe, L. R., & Walker, D. (1976). Mathematical education for engineers. Part II. Towards possible solutions. *International Journal of Mathematical Education in Science and Technology*, *7*(3), 349-364.

Ballinger, S. R. (1989, January). Topographic maps come home. *Science Scope*, *12*(4), 12-14.

Barba, R. H. (1985, April). Fossil study activities. *Science Scope*, *8*(4), 26-27.

Barclay, T. (1987, February). A graph is worth how many words? *Classroom Computer Learning*, *7*(5), 46-50.

Barrow, L. H. (1979, December). Real problem-solving in environmental education. *The American Biology Teacher*, *41*(9), 560-561.

Barry, D. M. (1989, September). Interest-bearing coins. *Science Scope*, *13*(1), 18-21.

Barry, D. M. (1990, September). Fat burgers. *Science Scope*, *14*(1), 34-36.

Benham, N. B., Hosticka, A., Payne, J. D., & Yeotis, C. (1982, January). Making concepts in science and mathematics visible and viable in the early childhood curriculum. *School Science and Mathematics*, *82*(1), 45-56.

Berkland, T. R., & Snoble, J. J. (1989, November). Rolling spheres: An activity in physical science. *School Science and Mathematics*, *89*(7), 578-582.

Berlin, D. F. (Ed.). (1989, May/June). SSMILES. Let's slide down the slope. *School Science and Mathematics*, *89*(5), 434-435.

Berlin, D. F. (Ed.). (1990, February). SSMILES. Soil structure and ground water. *School Science and Mathematics*, *90*(2), 162-164.

Berlin, D. F., & Nesbitt, D. (1990, January). SSMILES. Time travel: Negative numbers. *School Science and Mathematics*, *90*(1), 70-76.

Berlin, D. F., & Woolard, J. (1988, May). SSMILES. Feeding pleasure horses. *School Science and Mathematics*, *88*(5).

Birkeland, K. W., & Halfpenny, J. C. (1987, December). Winter ecology. *The Science Teacher*, *54*(9), 42-46.

Bitter, G. G. (1987, May). Editorial. The symbiosis of mathematics and science. *School Science and Mathematics*, *87*(5), 361-362.

Blackburn, K. T., & White, D. L. (1985, October). Measurement, mathematics, and music. *School Science and Mathematics*, *85*(6), 499-504.

Bly, J., & Ford, K. (1989, October). Sizing up solar energy. *Science and Children*, *27*(2), 14-15.

Boero, P. (1988, August). *Mathematics and science education from the ages of 6 to 14*. Paper presented at the meeting of The Sixth International Congress on Mathematical Education, Budapest, Hungary.

Borneli, C. L. (1991, January). Mathematics and meteorology: Perfect partners. *School Science and Mathematics*, *91*(1), 31-33.

Bright, G. W. (1979, November). Estimating physical measurements. *School Science and Mathematics*, *79*(8), 581-586.

Brouse, D. E. (1990, February). Population growth: Stretching the limits. *Science and Children*, *27*(5), 23-25.

Brouse, D. E. (1990, December). Population education. Awareness activities. *The Science Teacher*, *57*(9), 31-33.

Browdy, M. (1979, October). Viewing planet size. *Science and Children*, *17*(2), 28-30.

Burger, W. (1987, October). Ode to slinky on its birthday. *The Science Teacher*, *54*(7), 25-28.

Burghes, D. N. (1980, February). Mathematical modelling: A positive direction for the teaching of applications of mathematics at school. *Educational Studies in Mathematics, 11*(1), 113-131.

Burghes, D. N. (1980, October-December). Teaching applications of mathematics: Mathematical modelling in science technology. *European Journal of Science Education, 2*(4), 365-376.

Bybee, R., & McCormack, A. (1970, December). Applying Piaget's theory. *Science and Children, 8*(4), 14-18.

Calkins, J. R. (1989, January). Modeling the ocean in motion. *The Science Teacher, 56*(1), 28-30.

Clift, P. A. (1990, April). Air - A weighty matter. *The Science Teacher, 57*(4), 49-51.

Cocanour, B., & Bruce, A. S. (1986, March). The case of the soft-shelled egg. *Science and Children, 23*(6), 13-14.

Croll, D. A. (1986, March). Get cracking! *Science and Children, 23*(6), 14-17.

Czerwinski, W. P. (1989, December). A new lesson on the horizon. *The Science Teacher, 56*(9), 24-27.

Dean, P. G. (1975, January). A view of computing, mathematics and science in British education. *School Science and Mathematics, 75*(1), 21-29.

DeBruin, J. E., & Gibney, T. C. (1979, November). Solving everyday problems using mathematics and science process skills. *School Science and Mathematics, 79*(8), 613-617.

Demchik, M. J. (1985, February/March). How science activities can make mathematical conceptualizations a reality. *Science Activities, 22*(1), 24-26.

Demchik, M. J., Demchik, M. C., & Demchik, S. J. (1990, Spring). The wonder fish. *Science Activities, 27*(1), 20-21.

Demchik, M. J., & Demchik, V. C. (1985, February). Comparing variables with composite graphing. *Science Scope, 8*(3), 9.

De Moura, J. M., & Darrington, R. W. (1990, January). The great margarine melt. *The Science Teacher, 57*(1), 31-33.

Department of Interior, U.S. Geological Survey. (1971, January/February). How much water per inch of snow? *Science and Children, 8*(5), 27.

Donovan, E. P. (1989, January). Singular peanuts. *Science Scope*, *12*(4), 10-11.

Douglass, C., & Jones, S. (1988, February). SSMILES. This group . . . That group sorting leaves and making patterns. *School Science and Mathematics*, *88*(2).

Douglass, C., & Kurtz, R. (1987, May). SSMILES. How well hidden. Modeling natural selection. *School Science and Mathematics*, *87*(5).

Drake, D. E. (1987, October). Idea bank. Racing cars in physics class. *The Science Teacher*, *54*(7), 56.

Dubins, M. I. (1957, February). Integration of arithmetic with science through the study of weather in the elementary school. *School Science and Mathematics*, *57*(2), 121-130.

Dudley, B. A. C. (1975, December). Bringing mathematics to life. *Journal of Biological Education*, *9*(6), 263-268.

Dunlap, J. L., & Alberding, A. P. (1969, March). Interdepartmental team teaching — A physics-math course. *The Physics Teacher*, *7*(3), 163-165.

Duren, P. E., & Stronck, D. R. (1989, October). SSMILES. Heart throbs. *School Science and Mathematics*, *89*(6), 519-523.

Duren, P. E., & Stronck, D. R. (1989, November). SSMILES. Food labels. *School Science and Mathematics*, *89*(7), 608-616.

Dyche, S. E. (1985, November). Population activities for middle school science. *Science Scope*, *9*(2), 26-27.

Eichman, J. C., & Lundstrum, C. R. (1989, January). End diffusion confusion. *Science Scope*, *12*(4), 42-44.

Erikson, D. K. (1990, December). SSMILES. A graphing activity: Bottles. *School Science and Mathematics*, *90*(8), 732-736.

Evans, A. (1989, March). How many leagues under the sea? *Science Scope*, *12*(6), 40-42.

Farmer, W. A., & Farrell, M. A. (1989, Spring). *Activities for teaching K-6 math/science concepts*. (School Science and Mathematics Association Classroom Activities Series Number 2). Bowling Green, OH: School Science and Mathematics Association.

Fawley, J. P. (1981, January). Speleology: An approach to interdisciplinary lab science. *Journal of College Science Teaching*, *10*(3), 164-166.

Fehr, H. (1963, October). The role of physics in the teaching of mathematics. *The Mathematics Teacher*, *56*(6), 394-399.

Fields, S. (1987, November/December). The measure of the magnet. *Science and Children*, *25*(2), 12-13.

Flores, A. (1987, October). SSMILES. Family planning. *School Science and Mathematics*, *87*(6).

Foster, B. C., Mitchell, C. E., & Pool, G. L. (1991, March). Using the breathalyzer to integrate science and mathematics. *School Science and Mathematics*, *91*(3), 120-123.

Fowler, M. L. (1990, September). Glurch meets oobleck. *Science Scope*, *14*(1), 21-23.

Froschauer, L. K., & Boudrot, B. (1986, May). Helpful hints. A touch-and-go experience. *Science and Children*, *23*(8), 28.

Fuller, E. G. (1942, October). The correlation of mathematics and science in one unit. *School Science and Mathematics*, *42*(7), 665-668.

Gantert, R. L. (1981, February-March). Basic geometry applied to problem-solving in science. *Science Activities*, *18*(1), 30-26.

Gardella, J. R., & Sheffield, L. J. (1988, November). SSMILES. Bird parts and problems. *School Science and Mathematics*, *88*(7).

Gartrell, J. E., Jr., Crowder, J., & Callister, J. C. (1989, November/December). Taking the swamp out of "swamp water." *Science and Children*, *27*(3), 48-51.

Geier, T., & Wailes, J. R. (1979, September). Solar energy: Classroom reality. *Science and Children*, *17*(1), 19-20.

Gerber, D. T. (1989, September). Gears, ratios, and the bicycle. *Mathematics Teacher*, *82*(6), 466-468.

Ginther, J. (1988, January). How far does light travel in a nanosecond? *School Science and Mathematics*, *88*(1), 3-5.

Glenn, D. (1987, September). A forestful of lab activities. *The Science Teacher*, *54*(6), 51-53.

Goldberg, H., & Boulanger, D. (1981). Science for elementary school teachers: A quantitative approach. *American Journal of Physics*, *49*(2), 120-124.

Goldberg, H., & Wagreich, P. (1989, February). Focus on integrating science and math. *Science and Children*, *26*(5), 22-24.

Goldberg, V., Williams, S., & Hite, S. (1990, February). Edible density. *Science and Children*, *27*(5), 20-22.

Griffin, N. C. (1979, January). The day we hung the eighth grade. *The Science Teacher*, *46*(1), 24-25.

Griffiths, R. (1975, November/December). Making musical instruments as a springboard to science and math integration. *Science and Children*, *13*(2), 7-10.

Grouws, D. A., & Thomas, W. E. (1981, April). Problem solving: A panoramic approach. *School Science and Mathematics*, *81*(4), 307-314.

Gurley, L. I. (1983, September). Take a bird's-eye view. *Science and Children*, *21*(1), 19-21.

Hamrick, L., Harty, H., & Ault, C. (1987, December). Concept structure interrelatedness competency (ConSic): A tool for examining and promoting cognitive structure. *School Science and Mathematics*, *87*(8), 655-664.

Handlon, C. W. (1990, May). Idea bank. This lab is garbage! A "take home" activity. *The Science Teacher*, *57*(5), 70.

Hanshumaker, W. (1987, November/December). A head for chemistry. *Science and Children*, *25*(3), 24-26.

Hardeman, C. H., & Laquer, B. T. (1982). *Math and science. Module 5. MATHCO teacher's guide*. Norman, OK: Oklahoma University. (ERIC Document Reproduction Service No. ED 233 905).

Hart, K., Booth, L., & Turner, A. D. (1982, September). Mathematics-science links in the secondary school: Collaboration between mathematics and science departments. *Mathematics in School*, *11*(4), 2-3.

Heath, P. A. (1989, January/February). Integrating social studies with math and science. *Social Studies and the Young Learner*, *1*(3), 12-15.

Hein, H. C. (1972, June). What is your share of earth's water and air resources? *School Science and Mathematics*, *72*(6), 469-470.

Hobbs, J. (1985, May/June). Rubik's cube as a teaching tool for mathematics and science. *School Science and Mathematics*, *85*(5), 367-373.

Hogan, J. R., & Schall, W. E. (1973, May). Coordinating science and mathematics. *Science and Children*, *10*(8), 25-27.

House, P. A. (1980, April). *Interactions of science and mathematics. A set of activities.* (School Science and Mathematics Association Topics for Teachers Series No. 2). Columbus, OH: ERIC Clearinghouse for Science, Mathematics, and Environmental Education. (ERIC Document Reproduction Service No. ED 194 350)

House, P. A. (1987, April). An electrifying introduction to algebra. *Mathematics Teacher*, *80*(4), 301-311.

Humphreys, A., & Dailey, J. (Eds.). (1975). *Property blocks: Games and activities.* Minneapolis, MN: Minnesota University, Minnesota School Mathematics and Science Center. (ERIC Document Reproduction Service No. ED 127 167)

Hurst, D. (1980, February). Our solar system invades the curriculum. *Instructor*, *89*(7), 72.

Hynes, M., Douglass, C., & Jones, S. (1987, April). SSMILES. Capture recapture: Sampling with replacement. *School Science and Mathematics*, *87*(4).

Jamsen, J. A., & Laurich, W. (1988, April). SSMILES. The planets in perspective. *School Science and Mathematics*, *88*(4).

Jean, R. V., & Johnson, M. (1989, October). An adventure into applied mathematics with Fibonacci numbers. *School Science and Mathematics*, *89*(6), 487-498.

Johnson, M. B., & Burton, G. M. (1986, November). Developing number concepts through the seasons. *School Science and Mathematics*, *86*(7), 551-558.

Johnson, R. E. (1972, January). Mathematics - An emerging laboratory science strengthening the bonds. *School Science and Mathematics*, *72*(1), 39-42.

Johnson, R. K. (1980, February). JH/MS idea factory: Designs for middle school interdisciplinary studies. *English Journal*, *69*(2), 59-62.

Jones, E. E., & Jones, S. M. (1988, March). SSMILES. A new look in Grandma's button box. *School Science and Mathematics*, *88*(3).

Jones, H., & Bullock, R. (1979). *The sweet taste of spring: An integrated approach to a springtime phenomenon.* Willowdale, Ontario, Canada: Forest Valley

Outdoor Education Centre. (ERIC Document Reproduction Service No. ED 171 456)

Jones, T. B. (1971). *Adventures in science and math.* Minneapolis, MN: Minnesota University, Minnesota School Mathematics and Science Center. (ERIC Document Reproduction Service No. ED 127 168)

Jontos, N. (1989, January). Classification systems. *Science Scope*, *12*(4), 23.

Julyan, C. L. (1989, October). National Geographic Kids Network: Real science in the elementary classroom. *Classroom Computer Learning*, *10*(2), 30-33, 35-36, 38, 40-41.

Karplus, R. (1962). The science curriculum - One approach. *Elementary School Journal*, *62*(5), 243-252.

Kearney, E. I. (1979, March). Several routes to excellence. *Science and Children*, *16*(6), 42-43.

Keefer, J. W., & Kleehammer, D. R. (1990, October). Predicting packumin populations: Wildlife in a box. *The Science Teacher*, *57*(7), 26-27.

Kersh, M. E., Nielsen, M. E., & Subotnik, R. F. (1987). Techniques and sources for developing integrative curriculum for the gifted. *Journal for the Education of the Gifted*, *11*(1), 56-68.

Kim, H. (1990, November) SSMILES. Clay boat: A fun hands-on activity for mathematics and science. *School Science and Mathematics*, *90*(7), 642-647.

Kim, H., & Beary, J. (1991, March). SSMILES. Rusting steel wool. *School Science and Mathematics*, *91*(3), 124-127.

Kimmel, H. (1982, April). Energy topics in the mathematics classroom. *School Science and Mathematics*, *82*(4), 273-278.

Knapp, C. E. (1979, October). Exploring the outdoors with young people. *Science and Children*, *17*(2), 22-24.

Knight, C. W., II, & Schweitzer, J. P. (1972, February). Using stream flow to develop measuring skills. *The Arithmetic Teacher*, *19*(2), 88-89.

Kolodiy, G. O. (1984, February). A Piaget-based integrated math and science program. *Journal of College Science Teaching*, *13*(4), 297-299.

Koser, J. F. (1990, September). Doing the doppler: How to drive this concept home. *The Science Teacher*, *57*(6), 40-43.

Krockover, G. H. (1979, November). Solving everyday problems by applying science and mathematics principles. *School Science and Mathematics*, *79*(8), 607-612.

Kroto, J. J. (1988, November). Bridging the gap. *The Science Teacher*, *55*(8), 28-29.

Kuhl, P. W. (1986, April). Wordsearch graphics. *Science and Children*, *23*(7), 12.

Kullman, D. E. (1981, January). Math is where you find it. *School Science and Mathematics*, *81*(1), 42-50.

Kurtz, R. (1979, November). Condensing numerical information into charts, tables, and graphs in the primary grades. *School Science and Mathematics*, *79*(8), 597-601.

Kuserk, F. T. (1989, February). How-to-do-it: Measuring discharge and materials transport in stream ecosystems. *American Biology Teacher*, *51*(2), 100-102.

Lange, J., & Williamson, S. (1990, March). Reeling in data samples. *Science and Children*, *27*(6), 24-25.

Larkin, H. J., & Brackett, C. G. (1974). Mathematics prerequisites: A mastery approach. *American Journal of Physics*, *42*(12), 1089-1091.

Levine, S-H., Strauss, M. J., & Mortier, S. (1986, May). Soap bubbles and logic. *Science and Children*, *23*(8), 10-12.

Lewis, R. (1973, April-June). Mathematics for science—A problem for communication. *International Journal of Mathematical Education in Science and Technology*, *4*(2), 165-174.

Leyden, M. B. (1984, September). The water planet. An optical illusion. *Science Scope*, *8*(1), 8.

Leyden, M. (1985, October). Early adolescence. The strange silos. *Science and Children*, *23*(2), 32-33.

Leyden, M. B. (1986, February). Exploring nature's angles. *Science Scope*, *9*(3), 13.

Lind, K. K. (1989, April). Early childhood. Geologist for a day. *Science and Children*, *26*(7), 36-37.

Lind, K. K., & Milburn, M. J. (1988, February). Early childhood. Mechanized childhood. *Science and Children*, *25*(5), 32-33.

Lind, K., & Milburn, M. J. (1988, March). Early childhood. More for the mechanized child. *Science and Children*, *25*(6), 39-40.

Linn, M. C. (1987, November/December). An apple a day. *Science and Children*, *25*(2), 15-18.

Louviere, J. P. (1987, September). Idea bank. Molly on her swing. *The Science Teacher*, *54*(6), 75.

Lyon, B. C. (1987, November). SSMILES. A trip to the zoo - A lesson in graphing. *School Science and Mathematics*, *87*(7).

Mackinnon, N. (1987, March). Mountaineering mathematics. *Mathematics in School*, *16*(2), 20-21.

MacLeod, S., & Mills, G. (1986). *The teaching of science and technology in an interdisciplinary context. Approaches for the primary school.* Paris, France: UNESCO Division of Science Technical and Environmental Education. (ERIC Document Reproduction Service No. ED 279 518)

Maffei, A. C. (1976). School sounds and mathematics. *School Science and Mathematics*, *76*(5), 397-400.

Magno, M. C. (1990, March). Recycling scrap copper. *The Science Teacher*, *57*(3), 33-35.

Malone, J. (1989, November). Four labs to introduce quadratic functions. *Mathematics Teacher*, *82*(8), 601-604.

Malone, M. R. (1986, February). Investigating ramps and sliders. *Science and Children*, *23*(5), 11-14.

Mann-Lewis, M. (1989, February). Playing with planets. *Science and Children*, *26*(5), 34-37.

Markle, S. (1989, March). Let's explore Yellowstone! *Instructor*, *98*(7), 58-60.

Marston, R. E. (1980, October). Chutes and learners. *Teacher*, *98*(3), 64, 66.

Martin, K. (1989, February). The mathematics of bouncing balls. *School Science and Mathematics*, *89*(2), 157-165.

Mattingly, R. L. (1987, December). The dynamics of flowing waters. *The Science Teacher*, *54*(9), 23-27.

Mayer, V. J., & Fortner, R. (1986, May). An interdisciplinary data base for science investigations: Postage stamps. *School Science and Mathematics*, *86*(5), 395-402.

Mayor, J. R. (1970, April). Science and mathematics: 1970s — A decade of change. *The Arithmetic Teacher*, *17*(4), 293-297.

McBride, J. W., Zook, V., & Lamb, C. E. (1987, November). The classroom science and mathematics fair. *School Science and Mathematics*, *87*(7), 577-585.

McDonald, R. B. (1990, March). Wading pool regatta. *Science and Children*, *27*(6), 16-17.

McGrew, R. (1989, January). It's a liquid! It's a solid! It's oobleck! *Science Scope*, *12*(4), 6-8.

McKillip, W. D., & Kay, C. S. (1985, October). A few problems involving scale. *Mathematics Teacher*, *78*(7), 544-547.

McLeod, R. J. (1979). *Senator Wols and Professor Trams meet the energy multiplier. Teacher's guide. Net energy unit. Draft.* East Lansing, MI: Michigan State University, Science and Mathematics Teaching Center. (ERIC Document Reproduction Service No. ED 190 354)

McNairy, M. R. (1985, May/June). Sciencing: Science education for early childhood. *School Science and Mathematics*, *85*(5), 383-393.

McShane, J. B. (1987, September). The royal flush. *Science and Children*, *25*(1), 29-32.

Michael, V. (1989, October). Graphical analysis. *The Science Teacher*, *56*(7), 37-40.

Milner, W. W. (1987, March). Cross-curricular data activities. *Mathematics in School*, *16*(2), 30-32.

Milson, J. L. (1990, September). Electromagnetic attraction. *Science and Children*, *28*(1), 24-25.

Monahan, S. (1990, January). Hopping across the curriculum. *Science and Children*, *27*(4), 42-43.

Mooney, A. (1975, September). Some chemical applications of the 'new' mathematics. *The School Science Review*, *57*, 101-104.

Mruk, R. (1985, September). The wave machine. *Science Scope*, *9*(1), 10-11.

National Council of Teachers of Mathematics. (1942). *A sourcebook of mathematics applications*. Reston, VA: Author.

National Science Resources Center. (1988). *Science for children: Resources for teachers*. Washington, DC: National Academy Press.

National Science Teachers Association. (1978, November). *Mathematics in Energy*. Oak Ridge, TN: U.S. Department of Energy.

Neatrour, C. R. (1971, February). Madison's mathematics laboratory for preservice elementary science study. *School Science and Mathematics*, *71*(2), 154-158.

Nechamkin, H. (1975, April). Chemistry. Chemical routes to mathematical concepts. *The Science Teacher*, *42*(4), 43-44.

Neie, V. E. (1979, October). The multi-purpose astrolabe. *Science and Children*, *17*(2), 10-13.

Nelson, L. W. (1984). *Science activities for elementary children*. Dubuque, IA: W. C. Brown.

Nemcik, J. R. (1989, January). Modeling for ideas: The case of the missing volume. *Science Scope*, *12*(4), 28-31.

Newton, L. D. (1987, November). Fibonacci and nature. Mathematics investigations for schools. *Mathematics in School*, *16*(5), 2-8.

Nolan, W. T. (1977, December). Energy choices for consumers. *The Science Teacher*, *44*(9), 32-34.

Oakley, J. S. (1974, April). Reflections on integration of mathematics and science. *School Science and Mathematics*, *74*(4), 293-296.

O'Brien, G., & O'Farrell, C. A. (1988, January). SSMILES. Sampling: A method to count the number of stars in our galaxy. *School Science and Mathematics*, *88*(1).

Orton, W. R. (1988, January). The mathematics of fingerprints. *School Science and Mathematics*, *88*(1), 24-32.

Overmire, T. G. (1961, October). Mathematics in high school biology. *School Science and Mathematics*, *61*(7), 540-546.

Payne, W. H. (1957, January). Integrating learning as a result of exercises in mathematics and science. *School Science and Mathematics*, *57*(1), 37-40.

Peckham, G. D., Joubert, M. J., & McNaught, I. J. (1987, December). If you don't have a slicker, does it pay to walk quicker? *The Science Teacher*, *54*(9), 35-39.

Penafiel, A. F., & White, A. L. (1989, March). SSMILES. Exploration of the mean as a balance point. *School Science and Mathematics*, *89*(3), 251-258.

Peterson, E. (1989, October). Scaling science heights. *Science Scope*, *13*(2), 12-15.

Peterson, I. (1988). *The mathematical tourist*. New York: W. H. Freeman.

Probasco, G. (1982, October). Balloons away. *Science and Children*, *20*(2), 20-21.

Pugh, A. F., & Dukes-Bevans, L. (1987, November/December). Planting seeds in young minds. *Science and Children*, *25*(3), 19-21.

Ramseur, P. (1985, September). Teaching science with junk. *Science Scope*, *9*(1), 14.

Reeves, C. A. (1979, January). Energetic math. *The Science Teacher*, *46*(1), 35.

Rice, K. (1986, May). Soap films and bubbles. *Science and Children*, *23*(8), 4-10.

Riddle, B. (1988, January). E. T., call Nome...or Phoenix, or Burbank. *Science and Children*, *25*(4), 30-33.

Roberts, F. (1985, April). Using weather projects to make science relevant. *Science Scope*, *8*(4), 33.

Robiscoe, R. T. (1978, May). The effect of growth rate on conservation of a resource. *American Journal of Physics*, *41*, 719-720.

Romey, W. D. (1975, January). Transdisciplinary, problem-centered studies: Who is the integrator? *School Science and Mathematics*, *75*(1), 30-38.

Ronau, R. N., & Gilbert, R. K. (1988, November). Investigating relations in nature. *School Science and Mathematics*, *88*(7), 573-580.

Roth, W. (1989, November/December). Experimenting with temperature probes. *Science and Children*, *27*(3), 52-54.

Rowe, M. B., & McLeod, R. (1988, November-December). Science and math instruction: A new partnership. *Media and Methods*, *25*(2), 13-16, 72-73.

Saunders, W. L. (1985, November). The expansion of water upon freezing. *Science Scope*, *9*(2), 14.

Savoy, G. H. (1971). *Archery—A catalyst for subject integration.* Atikokan, Ontario, Canada: Marks Street School. (ERIC Document Reproduction Service No. ED 085 149)

Schamp, H. W., Jr. (1990, December). Model misunderstandings: Teach the limitations. *The Science Teacher*, *57*(9), 16-19.

Scharmann, L. C. (1989, November/December). Energy conservation: A project for grades 5-7. *Science Activities*, *26*(4), 8-13.

Schatz, A., & Kriebs, J. O. (1972). *Teaching science with soil.* Emmaus, PA: Rodale Press. (ERIC Document Reproduction Service No. ED 073 921)

Schatz, A., & Schatz, V. (1971). *Teaching science with garbage.* Emmaus, PA: Rodale Press. (ERIC Document Reproduction Service No. ED 073 904)

Scheider, W. (1987, October). Nature's variables. *The Science Teacher*, *54*(7), 44-49.

Schiller, P. & Townsend, J. (1985, October). Early childhood. Science all day long: An integrated approach. *Science and Children*, *23*(1), 34-36.

Schultz, J. M., & Coon, H. L. (1977). *Population education activities for the classroom.* Columbus, OH: ERIC Information Analysis Center for Science, Mathematics, and Environmental Education. (ERIC Document Reproduction Service No. ED 141 178)

Sells, L. W. (1978, February). The forum. Mathematics - A critical filter. *The Science Teacher*, *45*(2), 28-29.

Selnes, M. (1989, February). Have a science day! *Science Scope*, *12*(5), 18-19.

Shaw, E. L., Jr. (1987, September). Students and sponges - Soaking up science. *Science and Children*, *25*(1), 21.

Shaw, J. M., & Owens, L. L. (1987, November/December). Weather - Beyond observation. *Science and Children*, *25*(3), 27-28.

Sherman, L. (1989, March). Making the math/science connection. *Instructor*, *98*(7), 44-45, 48.

Shirk, G. B. (1979, November). Recording data - The overlooked component. *School Science and Mathematics*, *79*(8), 587-591.

Shrigley, R. L., & Trueblood, C. R. (1972, April). Non-verbal problem settings: A vehicle for the correlation of science and mathematics. *School Science and Mathematics*, *72*(4), 344-348.

Silverman, H. (Ed.). (1990, May). Ideas. Star Patterns. *Arithmetic Teacher*, *37*(9), 18-24.

Simmons, H. H. (1985). *Model rocketry in the elementary school* (Grades 4-6. Course guide). Penrose, CO: Estes Industries. (ERIC Document Reproduction Service No. ED 281 773)

Sims, W., & Oliver, A. (1950, November). The laboratory approach to mathematics. *School Science and Mathematics*, *50*(8), 621-627.

Skeel, D. (1968, April). *An integrated team teaching approach to methods course.* Paper presented at the meeting of the International Reading Association Conference, Boston, MA. (ERIC Document Reproduction Service No. ED 019 199).

Slesnick, I., Barrett, L., & McIntyre, P. (1990, September). Zoom! *Science and Children*, *28*(1), 40-41.

Smith, W. C. (1987, November). Idea bank. Three popcorn labs. *The Science Teacher*, *54*(8), 60.

The soil is alive. (1989, March). *Science and Children*, *26*(6), 48-49.

Stangl, J. (1982, October). No-cook cookery. Forty-five delicious learning activities based on a topic all kids love—food! *Instructor*, *92*(3), 40-42.

Steiner, P. (1990, September). A-Peelin' apples. *Science and Children*, *28*(1), 34-35.

Stepans, J. (1991, May/June). SSMILES. Will it mix, sink, or float? *School Science and Mathematics*, *91*(5), 218-220.

Stevens, P. S. (1974). *Patterns in nature.* Boston: Atlantic, Little, Brown.

Stronck, D. (1985, September). Wine bag to wind bag. *Science Scope*, *9*(1), 38.

Stubbs, H. S., Klinkhammer, M. L., & Knittig, M. (1985). *Elementary acid rain kit, interdisciplinary, Grade 4-8.* St. Paul, MN: Acid Rain Foundation. (ERIC Document Reproduction Service No. ED 270 302).

Tapson, F. (1987, March). Maths resource: Numbers and pictures. *Mathematics in School, 16*(2), 22-27.

Taylor, B. (1989, November). Electrostatic levitation. *The Science Teacher, 89*(8), 37-39.

Teaching guidelines for the observance of world meteorological day. (1985-1986). *International Understanding at School, 50-51*, 5-14. (ERIC Document Reproduction Service No. EJ 366 707)

Texley, J. (1989, January). A rational approach to radon. *Science Scope, 12*(4), 24-26.

Thompson, M. E. (1990, May/June). SSMILES. The geometry of parallel plate refraction. *School Science and Mathematics, 90*(5), 427-436.

Tinker, R. F. (1987, October). Educational technology and the future of science education. *School Science and Mathematics, 87*(6), 466-476.

Todd, R. M., & Todd, J. M. (1975). Teach something more than conversion. *Science Activities, 12*(6), 24-25.

Underwood, C. I., Twose, E. R., & Millar, R. H. (1987, January). Satellites in schools. *Physics Education, 22*(1), 44-49. (ERIC Document Reproduction Service No. EJ 352 996).

Uslabar, K. (1989, October). Snail stats. *The Science Teacher, 56*(7), 33-34.

Van Hise, Y. A. (1987, September). Physics with fizz. *The Science Teacher, 54*(6), 54-57.

Varner, L. (1987, December). Idea bank. Close the door - all the way. *The Science Teacher, 54*(9), 51-52.

Vaughan, B. (1977). The mathematics-science interface: A possible solution. *Mathematics in School, 6*(1), 25-27.

Walton, K. D. (1988, November). Examining functions in mathematics and science using computer interfacing. *School Science and Mathematics, 88*(7), 604-609.

Waterman, E. L., & Thompson, S. (1989, November). Microscale - the way of the future. *The Science Teacher, 89*(8), 29-31.

Webb, L. F., & Ost, D. H. (1975, January). Unifying science and mathematics in the elementary schools: One approach. *The Arithmetic Teacher, 22*(1), 67-72.

Webb, N. G. G. (1975). Correlating the teaching of mathematics and science. *International Journal of Mathematical Education in Science Technology*, *6*(1), 105-110.

Weiner, E. B. (1989, November/December). Culling all cranberries. *Science and Children*, *27*(3), 20-21.

Wells, G., & Berger, C. (1985-1986, Winter). Teacher/student-developed spreadsheet simulations: A population growth example. *Journal of Computers in Mathematics and Science Teaching*, *5*(2), 34-40.

Wheeler, G. (1983). *A weekend drive: Source for an interdisciplinary teaching unit.* Portales, NM: Eastern New Mexico University. (ERIC Document Reproduction Service No. ED 235 076)

White, A. L., & Berlin, D. F. (1987, December). SSMILES. Sampling and inference. *School Science and Mathematics*, *87*(8).

White, A. L., & Berlin, D. F. (1988, October). SSMILES. Temperature measurement. *School Science and Mathematics*, *88*(6).

White, A. L., & Berlin, D. F. (1989, April). SSMILES. Fulcrum and mean: Concepts of balance. *School Science and Mathematics*, *89*(4), 335-342.

Whitmer, J. C. (1987, November). Are your students proportionality literate? *The Science Teacher*, *54*(8), 37-39.

Whitmer, J. C. (1990, October). Modeling the Milky Way: Spreadsheet science. *The Science Teacher*, *57*(7), 19-21.

Wiebe, J. H., Heim, J. D., & Crawford, A. N. (1987, December). Snails, statistics, and computers. *School Science and Mathematics*, *87*(8), 665-671.

Wiener, G. (1987, September). Kaleidoscope caper. *Science and Children*, *25*(1), 41-43.

Williams, J. (1973, January). Why can't they divide? or the maths/science dilemma. *Mathematics in School*, *2*(1), 3-4.

Yant, S. L. (1976, March). Facing the energy crisis in a mathematics classroom. *The Arithmetic Teacher*, *23*(3), 223-224.

Young, S. L. (1991, March). Ideas. Fingerprints. *The Arithmetic Teacher*, *38*(7), 24-33.

Ziemer, M. (1987, September). Science and the early childhood curriculum: One thing leads to another. *Young Children*, *42*(6), 44-51.

Zipko, S. J. (1983, November). How-to-do-it: An interdisciplinary approach to forestry education. *The American Biology Teacher*, *45*(7), 387-392.

Research

Agris, M. S., & Austin, J. D. (1984, May/June). Women in "school science and mathematics" — The early years. *School Science and Mathematics*, *84*(5), 386-394.

Ayers, J. B., & Ayers, M. N. (1973, December). Influence of SAPA on kindergarten children's use of logic in problem solving. *School Science and Mathematics*, *73*(8), 768-771.

Ayers, J. B., & Mason, G. E. (1969, February). Differential effects of Science - A Process Approach upon change in Metropolitan Readiness Test scores among kindergarten children. *Reading Teacher*, *22*(5), 435-439.

Berlin, D. F. (1989, January). The integration of science and mathematics education: Exploring the literature. *School Science and Mathematics*, *89*(1), 73-80.

Cain, R. W., & Lee, E. C. (1963, December). An analysis of the relationship between science and mathematics at the secondary school level. *School Science and Mathematics*, *63*(9), 705-713.

Farrell, E. (1988, December). How teaching proportionality affects transfer of learning: Science and math teachers need each other. *School Science and Mathematics*, *88*(8), 688-695.

Farrell, M. A., & Farmer, W. A. (1985). Adolescents' performance on a sequence of proportional reasoning tasks. *Journal of Research in Science Teaching*, *22*(6), 503-518.

Friedel, A. W., Gabel, D. L., & Samuel, J. (1990, December). Using analogs for chemistry problem solving: Does it increase understanding? *School Science and Mathematics*, *90*(8), 674-682.

Friend, H. (1985, October). The effect of science and mathematics integration on selected seventh grade students' attitudes toward and achievement in science. *School Science and Mathematics*, *85*(6), 453-461.

Friend, H., Wisotsky, M., Sega, J., & Petosa, R. (1984). *How does science and mathematics correlation in a seventh grade physics unit affect selected seventh grade students' attitudes toward achievement in science*? Paper presented at the meeting of the National Association for Research in Science Teaching, New Orleans, LA.

Gabel, D. (1986, February). Research applications: Science-education partnerships. *Science Scope*, *9*(3), 18-19.

Gabel, D. L., & Samuel, K. V. (1986). High school students' ability to solve molarity problems and their analog counterparts. *Journal of Research in Science Teaching*, *23*(2), 165-176.

Gabel, D. L., & Sherwood, R. D. (1983). Facilitating problem solving in high school chemistry. *Journal of Research in Science Teaching*, *20*(2), 163-177.

Gabel, D. L., & Sherwood, R. D. (1984). Analyzing difficulties with mole-concept tasks by using familiar analog tasks. *Journal of Research in Science Teaching*, *21*(8), 843-851.

Gabel, D. L., Sherwood, R. D., & Enochs, L. (1984). Problem-solving skills of high school chemistry students. *Journal of Research in Science Teaching*, *21*(2), 221-233.

Good, R. (1991). Editorial. Research on science-mathematics connections. *Journal of Research in Science Teaching*, *28*(2), 109.

Gorman, F. H. (1943, December). An experiment in integrating seventh and eighth grade science and mathematics. *Science Education*, *27*(4), 130-134.

Henry, L. L., & Rowsey, R. E. (1978, July-September). Comparative study of the knowledge of metric units of measure and their application. *Science Education*, *62*(3), 283-289.

Hudson, H. T., & Rottmann, R. M. (1981, July). Correlation between performance in physics and prior mathematics knowledge. *Journal of Research in Science Teaching*, *18*(4); 291-294.

Koballa, T. R., Jr., & Bethel, L. J. (1984). Integration of science and other school subjects. In D. Holdzkom & P. B. Lutz (Eds.), *Research within reach: Science education* (pp. 79-107). Washington, DC: National Institute of Education.

Kolb, J. R. (1967-1968). Effects of relating mathematics to science instruction on the acquisition of quantitative science behaviors. *Journal of Research in Science Teaching*, *5*(2), 174-182.

Kouba, V. L. (1989, November). Common and uncommon ground in mathematics and science terminology. *School Science and Mathematics*, *89*(7), 598-606.

Krajcik, J. S., & Haney, R. E. (1987, January). Proportional reasoning and achievement in high school chemistry. *School Science and Mathematics, 87*(1), 25-32.

Kren, S. R. (1976). *The effects of integrated science-mathematics curriculum on specific mathematical skills.* Unpublished master's thesis, The University of Texas at Austin.

Kren, S. R., & Huntsberger, J. P. (1977). Should science be used to teach mathematical skills? *Journal of Research in Science Teaching, 14*(6), 557-561.

Lawrenz, F., & Orton, R. E. (1989, May-June). A comparison of critical thinking related teaching practices of seventh and eighth grade science and mathematics teachers. *School Science and Mathematics, 89*(5), 361-372.

Lawson, A. E., & Bealer, J. M. (1984). The acquisition of basic quantitative reasoning skills during adolescence: Learning or development? *Journal of Research in Science Teaching, 21*(4), 417-423.

Lehman, J. R., & McDonald, J. L. (1988, December). Teachers' perceptions of the integration of mathematics and science. *School Science and Mathematics, 88*(8), 642-649.

Lockwood, J. B. (1959, February). The mathematical processes needed in learning high- school chemistry and high-school physics. *Science Education, 43*(1), 56-60.

Maloney, D. P. (1983, April). Proportional reasoning and rule-governed behavior with the balance beam. *Science Education, 67*(2), 245-254.

Nachmias, R., & Linn, M. C. (1987, May). Evaluations of science laboratory data: The role of computer-presented information. *Journal of Research in Science Teaching, 24*(5), 491-506.

Padilla, M. J., McKenzie, D. L., & Shaw, E. L., Jr. (1986, January). An examination of the line graphing ability of students in grades seven through twelve. *School Science and Mathematics, 86*(1), 20-26.

Pallrand, G. J., & Seeber, F. (1984). Spatial ability and achievement in introductory physics. *Journal of Research in Science Teaching, 21*(5), 507-516.

Parque, R. A. (1966, May). An experimental study to investigate the mathematical needs of students in a traditional physics course. *School Science and Mathematics, 66*(5), 405-409.

Pratt, D. L. (1985, May/June). Mathematics usage in secondary science courses and textbooks. *School Science and Mathematics*, *85*(5), 394-406.

Reyes, L. H., & Padilla, M. J. (1985, September). Science, math, and gender. *The Science Teacher*, *52*(6), 47-48.

Russell, J. M., & Chiappetta, E. L. (1981). The effects of a problem solving strategy on the achievement of earth science students. *Journal of Research in Science Teaching*, *18*(4), 295-301.

Smith, E. L., & Padilla, M. J. (1977). Strategies used by first-grade children in ordering varying numbers of objects by length and weight. *Journal of Research in Science Teaching*, *14*(5), 461-466.

Stafford, D. G., & Renner, J. W. (1971, February). SCIS helps the first grader to use logic in problem solving. *School Science and Mathematics*, *71*(2), 159-164.

Stafford, D. G., & Renner, J. W. (1976). Development of conservation reasoning through experience. In J. W. Renner, D. G. Stafford, A. E. Lawson, J. W. McKinnon, F. E. Friot, & D. H. Kellogg (Eds.), *Research, teaching, and learning with the Piaget model* (pp. 34-55). Norman, OK: University of Oklahoma Press.

Wheeler, A., & Kass, H. (1977). *Proportional reasoning in introductory high school chemistry*. Paper presented at the meeting of The National Association for Research in Science Teaching, Cincinnati, OH. (ERIC Document Reproduction Service No. ED 139 620)

Curriculum–Instruction

Adair, R., Ewing, J., Faircloth, S., Nikoghosian, J., Peterson, C., Smith, D., & Wiebe, S. (Eds.). (1987). *Fall into math and science. K-1. Book 1.* Fresno, CA: AIMS Education Foundation. (ERIC Document Reproduction Service No. ED 283 688)

Adams, P. (Ed.). (1971). *Change and calculations: MINNEMAST coordinated mathematics-science series, unit 24.* Minneapolis, MN: Minnesota University, Minnesota School Mathematics and Science Center. (ERIC Document Reproduction Service No. ED 127 192)

Adams, P. A. (Ed.). (1970). *Overview: MINNEMAST.* Minneapolis, MN: Minnesota University, Minnesota School Mathematics and Science Center. (ERIC Document Reproduction Service No. ED 127 164)

Adams, P. (Ed.). (1971). *Numbers and their properties: MINNEMAST coordinated mathematics-science series, unit 27.* Minneapolis, MN: Minnesota University, Minnesota School Mathematics and Science Center. (ERIC Document Reproduction Service No. ED 127 195)

Agler, L. (1987). *Liquid explorations.* Berkeley, CA: Lawrence Hall of Science Great Explorations in Math and Science (GEMS).

Agro, S. (1976). *Advertising - USMES teacher resource book* (2nd ed.). Newton, MA: Education Development Center. (ERIC Document Reproduction Service No. ED 220 299)

Agro, S. (1976). *Manufacturing - USMES teacher resource book* (2nd ed.). Newton, MA: Education Development Center. (ERIC Document Reproduction Service No. ED 220 310)

Agro, S. (1977). *Using free time - USMES teacher resource book* (2nd ed.). Newton, MA: Education Development Center. (ERIC Document Reproduction Service No. ED 220 322)

Agro, S., Beck, B. M., Brady, L. R., Jr., Keskulla, J., & Klein, P. (1977). *Collecting data. USMES intermediate "how to" set.* Newton, MA: Education Development Center. (ERIC Document Reproduction Service No. ED 220 327)

Agro, S., Beck, B. M., Brady, L. R., Jr., Keskulla, J., & Klein, P. (1977). *Graphing. USMES intermediate "how to" set.* Newton, MA: Education Development Center. (ERIC Document Reproduction Service No. ED 220 330)

Agro, S., Beck, B. M., Brady, L. R., Jr., Keskulla, J., & Klein, P. (1977). *Measuring. USMES intermediate "how to" set.* Newton, MA: Education Development Center. (ERIC Document Reproduction Service No. ED 220 332)

Agro, S., Beck, B. M., Brady, L. R., Jr., Keskulla, J., & Klein, P. (1977). *Simplifying data. USMES intermediate "how to" set.* Newton, MA: Education Development Center. (ERIC Document Reproduction Service No. ED 220 334)

Agro, S., Beck, B. M., Brady, L. R., Jr., Keskulla, J., & Manfre, E. (1977). *Biology. USMES beginning "how to" set.* Newton, MA: Education Development Center. (ERIC Document Reproduction Service No. ED 220 325)

Agro, S., Beck, B. M., Brady, L. R., Jr., & Manfre, E. (1977). *Collecting data. USMES beginning "how to" set.* Newton, MA: Education Development Center. (ERIC Document Reproduction Service No. ED 220 326)

Agro, S., Beck, B. M., Brady, L. R., Jr., & Manfre, E. (1977). *Electricity. USMES beginning "how to" set.* Newton, MA: Education Development Center. (ERIC Document Reproduction Service No. ED 220 328)

Agro, S., Beck, B. M., Brady, L. R., Jr., & Manfre, E. (1977). *Graphing. USMES beginning "how to" set.* Newton, MA: Education Development Center. (ERIC Document Reproduction Service No. ED 220 329)

Agro, S., Beck, B. M., Brady, L. R., Jr., & Manfre, E. (1977). *Measuring. USMES beginning "how to" set.* Newton, MA: Education Development Center. (ERIC Document Reproduction Service No. ED 220 331)

Agro, S., Beck, B. M., Brady, L. R., Jr., & Manfre, E. (1977). *Simplifying data. USMES beginning "how to" set.* Newton, MA: Education Development Center. (ERIC Document Reproduction Service No. ED 220 333)

Agro, S., & Sampson, S. S. (1977). *Soft drink design - USMES teacher resource book* (4th ed.). Newton, MA: Education Development Center. (ERIC Document Reproduction Service No. ED 220 320)

Ahouse, J. J. (1987). *Fingerprinting. Teacher's guide.* Berkeley, CA: Lawrence Hall of Science Great Explorations in Math and Science (GEMS).

Bakke, J., Bray, E. C., & Reed, E. W. (1972). *Natural systems: MINNEMAST coordinated mathematics-science series, unit 29.* Minneapolis, MN: Minnesota University, Minnesota School Mathematics and Science Center. (ERIC Document Reproduction Service No. ED 127 197)

The Bank Street College of Education. (1985). *The voyage of the Mimi*. Scotts Valley, CA: WINGS for Learning.

The Bank Street College of Education. (1989). *The second voyage of the Mimi*. Scotts Valley, CA: WINGS for Learning.

Barber, J. (1986). *Chemical reactions. Teacher's guide*. Berkeley, CA: Lawrence Hall of Science Great Explorations in Math and Science (GEMS).

Barber, J. (1987). *Bubbleology. Teacher's guide*. Berkeley, CA: Lawrence Hall of Science Great Explorations in Math and Science (GEMS). (ERIC Document Reproduction Service No. ED 315 301)

Barber, J. (1988). *Vitamin C testing*. Berkeley, CA: Lawrence Hall of Science Great Explorations in Math and Science (GEMS).

Barrett, K. (1987). *Mapping animal movements. Teacher's guide*. Berkeley, CA: Lawrence Hall of Science Great Explorations in Math and Science (GEMS).

Bell, L. P. (1974). *Elementary career education units for integration in subject areas at grades kindergarten through six. Project SPAN*. (ERIC Document Reproduction Service No. ED 107 925)

Bernstein-Sidney, E. (1976). *Play area design and use - USMES teacher resource book* (3rd ed.). Newton, MA: Education Development Center. (ERIC Document Reproduction Service No. ED 220 315)

Bernstein-Sidney, E. (1976). *Weather predictions - USMES teacher resource book* (4th ed.). Newton, MA: Education Development Center. (ERIC Document Reproduction Service No. ED 220 324)

Biersteker, J., Bursheim, J., & Kraby, J. (1971). *Angles and space: MINNEMAST coordinated mathematics-science series, unit 26*. Minneapolis, MN: Minnesota University, Minnesota School Mathematics and Science Center. (ERIC Document Reproduction Service No. ED 127 189)

Blair, K. W., & Edmunds, P. T. (1971). *Interpretations of addition and subtraction: MINNEMAST coordinated mathematics-science series, unit 13*. Minneapolis, MN: Minnesota University, Minnesota School Mathematics and Science Center. (ERIC Document Reproduction Service No. ED 127 181)

Blair, K. W., & Edmunds, P. T. (1971). *Introducing addition and subtraction: MINNEMAST coordinated mathematics-science series, unit 11*. Minneapolis,

MN: Minnesota University, Minnesota School Mathematics and Science Center. (ERIC Document Reproduction Service No. ED 127 179)

Blair, K. W., & Forseth, S. D. (1971). *Exploring symmetrical patterns: MINNEMAST coordinated mathematics-science series, unit 14.* Minneapolis, MN: Minnesota University, Minnesota School Mathematics and Science Center. (ERIC Document Reproduction Service No. ED 127 182)

Blair, K. W., & Forseth, S. D. (1971). *Introducing symmetry: MINNEMAST coordinated mathematics-science series, unit 7.* Minneapolis, MN: Minnesota University, Minnesota School Mathematics and Science Center. (ERIC Document Reproduction Service No. ED 127 175)

Blair, K. W., & Thomson, P. V. (1971). *Numbers and counting: MINNEMAST coordinated mathematics-science series, unit 9.* Minneapolis, MN: Minnesota University, Minnesota School Mathematics and Science Center. (ERIC Document Reproduction Service No. ED 127 177)

Bliss, S. M. (1972). *Do you see what I see. Project on elementary school mathematics and science.* Urbana, IL: University of Illinois.

Blueford, J. R., & others. (1985). *Science, math, and technology. K-6 science curriculum.* Reston, VA: Geological Survey (Department of Interior); Fremont, CA: Math Science Nucleus. (ERIC Document Reproduction Service No. ED 265 048)

Board on Mathematical Sciences. (1986, October). Mathematics: The unifying thread in science. *Notices of the American Mathematical Society, 33*(5), 716-733.

Bolduc, E., Friedman, B., Geballe, T. H., Gelmers, A. L., Greenstadt, M., Hammond, E. E., Jr., Haygood, N., Kadesch, R. R., Lindsay, F., Meyer, E., Starkey, R., Thwaites, B., Tuske, A. M., Zant, J. H., & Sandmann, W. (1963). *Mathematics through science. Part II: Graphing, equations and linear functions. Teacher commentary. Preliminary edition.* Stanford University, CA: School Mathematics Study Group. (ERIC Document Reproduction Service No. ED 190 389)

Brady, L. R., Jr. (1977). *Getting there - USMES teacher resource book* (2nd ed.). Newton, MA: Education Development Center. (ERIC Document Reproduction Service No. ED 220 308)

Brady, L. R., Jr. (1977). *Orientation - USMES teacher resource book* (3rd ed.). Newton, MA: Education Development Center. (ERIC Document Reproduction Service No. ED 220 313)

Brady, L. R., Jr., & Keskulla, J. (1977). *Growing plants - USMES teacher resource book* (2nd ed.). Newton, MA: Education Development Center. (ERIC Document Reproduction Service No. ED 220 309)

Bray, E. C., & Redin, P. (1971). *Multiplication and motion: MINNEMAST coordinated mathematics-science series, unit 25.* Minneapolis, MN: Minnesota University, Minnesota School Mathematics and Science Center. (ERIC Document Reproduction Service No. ED 127 193)

Brown, F. F. (1984). *Nutrition education: An integrated multidisciplinary approach. Nutrition education curriculum for Georgia middle schools, grades 5-8.* Atlanta, GA: Georgia Department of Education. (ERIC Document Reproduction Service No. ED 271 465)

Brown, W. R., & Wall, C. E. (1976). *Career education resource units. Middle school: Vol. I.* Washington, DC: Office of Education (DHEW). (ERIC Document Reproduction Service No. ED 142 783)

Brown, W. R., & Wall, C. E. (1976). *Career education resource units. Middle school: Vol. II.* Washington, DC: Office of Education (DHEW). (ERIC Document Reproduction Service No. ED 142 784)

Brown, W. R., & Wall, C. E. (1976, November). A look at the integration of science and mathematics in the elementary school - 1976. *School Science and Mathematics, 76*(7), 551-562.

Buegler, M. E. (1988). *Discovering density. Teacher's guide.* Berkeley, CA: Lawrence Hall of Science Great Explorations in Math and Science (GEMS).

Bussey, M. K. (1976). *Bicycle transportation - USMES teacher resource book* (2nd ed.). Newton, MA: Education Development Center. (ERIC Document Reproduction Service No. ED 220 300)

Bussey, M. K. (1976). *Describing people - USMES teacher resource book* (5th ed.). Newton, MA: Education Development Center. (ERIC Document Reproduction Service No. ED 220 304)

Bussey, M. K. (1976). *Designing for human proportions - USMES teacher resource book* (4th ed.). Newton, MA: Education Development Center. (ERIC Document Reproduction Service No. ED 220 306)

Bussey, M. K. (1976). *Protecting property - USMES teacher resource book* (1st ed.). Newton, MA: Education Development Center. (ERIC Document Reproduction Service No. ED 220 316)

Bussey, M. K. (1977). *Classroom management - USMES teacher resource book* (2nd ed.). Newton, MA: Education Development Center. (ERIC Document Reproduction Service No. ED 220 302)

Bussey, M. K. (1977). *School rules - USMES teacher resource book* (2nd ed.). Newton, MA: Education Development Center. (ERIC Document Reproduction Service No. ED 220 317)

Calvert, J. B., Tuttle, E. R., Martin, M. S., & Warren, P. (1981, February). The age of Newton: An intensive interdisciplinary course. *History Teacher*, *14*(2), 167-190.

Cohen, H., & Staley, F. (1982, November). Integrating with science: One way to bring science back into the elementary school day. *School Science and Mathematics*, *82*(7), 565-572.

Crumb, G. H., & Barry, D. (1968). *An exploratory project on training elementary teachers in mathematics and science.* Emporia, KS: Kansas State Teachers College; San Jose, CA: San Jose State College. (ERIC Document Reproduction Service No. ED 025 439)

David, E. (Ed.). (1971). *Investigating systems: MINNEMAST coordinated mathematics- science series, unit 15.* Minneapolis, MN: Minnesota University, Minnesota School Mathematics and Science Center. (ERIC Document Reproduction Service No. ED 127 183)

Davis, E. R. (Ed.). (1971). *Scaling and representation: MINNEMAST coordinated mathematics-science series, unit 18.* Minneapolis, MN: Minnesota University, Minnesota School Mathematics and Science Center. (ERIC Document Reproduction Service No. ED 127 186)

Disinger, J. F., & Lisowski, M. (1985). *Teaching about hazardous and toxic materials. Teaching activities in environmental education series.* Columbus, OH: ERIC Clearinghouse for Science, Mathematics, and Environmental Education. (ERIC Document Reproduction Service No. ED 273 432)

DiVincenzo, R. M. (1973, June). Measurement-Science: An elementary program in math-science curriculum development. *School Science and Mathematics*, *73*(6), 444-452.

Donahoe, C., Low, B., & Saalfield, J. (1977). *Design lab. USMES "how to" series.* Newton, MA: Education Development Center. (ERIC Document Reproduction Service No. ED 220 335)

Dyrud, G. H., & Page, L. M. (1971). *Describing and classifying: MINNEMAST coordinated mathematics-science series, unit 3*. Minneapolis, MN: Minnesota University, Minnesota School Mathematics and Science Center. (ERIC Document Reproduction Service No. ED 127 171)

Dyrud, G. H., & Page, L. M. (1971). *Numeration: MINNEMAST coordinated mathematics-science series, unit 6*. Minneapolis, MN: Minnesota University, Minnesota School Mathematics and Science Center. (ERIC Document Reproduction Service No. ED 127 174)

Dyrud, G. H., Page, L. M., Klaits, B. G., & Reed, E. W. (1971). *Observing properties: MINNEMAST coordinated mathematics-science series, unit 8*. Minneapolis, MN: Minnesota University, Minnesota School Mathematics and Science Center. (ERIC Document Reproduction Service No. ED 127 176).

Echols, J. C. (1986). *Hide a butterfly. Teacher's guide*. Berkeley, CA: Lawrence Hall of Science Great Explorations in Math and Science (GEMS).

Edmunds, P. T., & Schrankler, W. J. (1971). *Introducing measurement: MINNEMAST coordinated mathematics-science series, unit 5*. Minneapolis, MN: Minnesota University, Minnesota School Mathematics and Science Center. (ERIC Document Reproduction Service No. ED 127 173)

Education Development Center. (1969). *Goals for the correlation of elementary science and mathematics. The report of The Cambridge Conference on the Correlation of Science and Mathematics in the Schools*. New York: Houghton-Mifflin. (ERIC Document Reproduction Service No. ED 042 599)

Gleason, A. M. (1968, January). Science, math, and tomorrow's child. Report from The Cambridge Conference. *The Instructor*, *77*(5), 54-56.

Goldberg, H., & Wagreich, P. (1991). *TIMS (Teaching Integrated Mathematics and Science) Curriculum module for grades 1-8*. Chicago, IL: TIMS Project, University of Illinois at Chicago.

Goodstein, M. P. (1983). *Sci-Math: Applications in proportional problem solving. Module one teacher's guide*. Menlo Park, CA: Addision-Wesley. (ERIC Document Reproduction Service No. ED 301 412)

Goodstein, M. P. (1983). *Sci-Math: Applications in proportional problem solving. Module two teacher's guide*. Menlo Park, CA: Addison-Wesley. (ERIC Document Reproduction Service No. ED 301 414)

Gould, A. (1986). *Hot water and warm homes from sunlight. Teacher's guide.* Berkeley, CA: Lawrence Hall of Science Great Explorations in Math and Science (GEMS).

Grogan, J., & Armillay, J. (Eds.). (1978). *Nutrition education: An interdisciplinary approach. Revised edition, 1978. Developed through an inservice program of the nutrition education development project. Administered by Luzerne Intermediate Unit 18.* Kingston, PA: Luzerne Intermediate Unit 18. (ERIC Document Reproduction Service No. ED 164 968)

Hall, W. D. (1985). *Oceans: A multi-age, integrated subjects curriculum unit.* Bozeman, MT: Montana State University - Bozeman, College of Education. (ERIC Document Reproduction Service No. ED 269 184)

Hall, W. D. (1985). *Outer space: A multi-age, integrated subjects curriculum unit.* Bozeman, MT: Montana State University - Bozeman, College of Education. (ERIC Document Reproduction Service No. ED 269 183)

Hall, W. D. (1985). *Weather: A multi-age, integrated subjects curriculum unit.* Bozeman, MT: Montana State University - Bozeman, College of Education. (ERIC Document Reproduction Service No. ED 269 182)

Hillen, J. A. (1986). *Pieces and patterns: A patchwork in math and science.* (Project AIMS grades 5-9. Book 8). Fresno, CA: AIMS Education Foundation. (ERIC Document Reproduction Service No. ED 283 707)

Hillen, J., & Hoover, E. (Eds.). (1990). *Primarily plants. A plant study for K-3.* Fresno, CA: AIMS Education Foundation.

Hillen, J., Hoover, E., & Mercier, S. (Eds.). (1990). *Primarily physics. Investigations in sound, light & heat energy. K-3.* Fresno, CA: AIMS Education Foundation.

Hillen, J., Wiebe, A., & Youngs, D. (Eds.). (1988). *Water precious water. A collection of elementary activities. Grades 2-6.* Fresno, CA: AIMS Education Foundation.

Hillen, J., Wiebe, A., & Youngs, D. (Eds.). (1989). *Critters. K-6 Life science activities.* Fresno, CA: AIMS Education Foundation.

House, P. A. (Ed.). (1990). *Science and mathematics: Partners then...Partners now.* (School Science and Mathematics Association Topics for Teachers Series Number 5). Bowling Green, OH: School Science and Mathematics Association.

Humphreys, A., & Post, T. R. (1970). *MINNEMAST recommendations for science and math in the intermediate grades.* Minneapolis, MN: Minnesota University, Minnesota School Mathematics and Science Center. (ERIC Document Reproduction Service No. ED 127 165)

I. D. S. (Interdisciplinary studies in general education): A program for the 80's. (1980). Orlando, FL: Valencia Community College. (ERIC Document Reproduction Service No. ED 207 635)

Ihrig, E. A. (Ed.). (1971). *Introducing multiplication and division, kangaroos and numbers: MINNEMAST coordinated mathematics-science series, unit 17.* Minneapolis, MN: Minnesota University, Minnesota School Mathematics and Science Center. (ERIC Document Reproduction Service No. ED 127 185)

Ihrig, E. A. (Ed.). (1971). *Mapping the globe, transformation: MINNEMAST coordinated mathematics-science series, unit 28.* Minneapolis, MN: Minnesota University, Minnesota School Mathematics and Science Center. (ERIC Document Reproduction Service No. ED 127 196)

Ihrig, E. A. (Ed.). (1971). *Using larger numbers: MINNEMAST coordinated mathematics-science series, unit 20.* Minneapolis, MN: Minnesota University, Minnesota School Mathematics and Science Center. (ERIC Document Reproduction Service No. ED 127 188)

Interdisciplinary studies program. Introduction to teacher's guide. (1984). Orlando, FL: Valencia Community College. (ERIC Document Reproduction Service No. ED 245 768)

Jennings, M. (1971, December). SOCKEMS. Socks it to 'em in math-science. *Science and Children*, 9(4), 5-8.

Jones, C. (1980). *Beach profiles and transects. Ocean related curriculum activities.* Seattle, WA: Pacific Science Center. (ERIC Document Reproduction Service No. ED 289 673)

Keller, M. K., & others. (1980). *UMAP modules - Units 105, 107-109, 111-112, 158-162.* Newton, MA: Education Development Center. (ERIC Document Reproduction Service No. ED 214 786)

Keskulla, J. (1976). *Pedestrian crossing - USMES teacher resource book* (5th ed.). Newton, MA: Education Development Center. (ERIC Document Reproduction Service No. ED 220 314)

Keskulla, J. (1976). *Traffic flow - USMES teacher resource book* (4th ed.). Newton, MA: Education Development Center. (ERIC Document Reproduction Service No. ED 220 321)

Keskulla, J. (1977). *Nature trails - USMES teacher resource book* (2nd ed.). Newton, MA: Education Development Center. (ERIC Document Reproduction Service No. ED 220 312)

Keskulla, J., & Bussey, M. K. (1977). *Eating in school - USMES teacher resource book* (1st ed.). Newton, MA: Education Development Center. (ERIC Document Reproduction Service No. ED 220 307)

Keskulla, J., & Gubbins, S. (1977). *School zoo - USMES teacher resource book* (3rd ed.). Newton, MA: Education Development Center. (ERIC Document Reproduction Service No. ED 220 319)

Kraby, J., & Rieff, M. (1971). *Describing locations: MINNEMAST coordinated mathematics-science series, unit 10.* Minneapolis, MN: Minnesota University, Minnesota School Mathematics and Science Center. (ERIC Document Reproduction Service No. ED 127 178)

Kraby, J., & Rieff, M. (1971). *Measurement with reference units: MINNEMAST coordinated mathematics-science series, unit 12.* Minneapolis, MN: Minnesota University, Minnesota School Mathematics and Science Center. (ERIC Document Reproduction Service No. ED 127 180)

Kurtz, R., & James, R. K. (1975, March). Implementation of an integrated program of Science: A Process Approach and Nuffield Mathematics. *School Science and Mathematics, 75*(3), 258-266.

Lawrence Hall of Science Great Explorations in Math and Science (GEMS). (1987). *Exhibit guide. Shapes, loops & images.* Berkeley, CA: Author.

Learning Technology Center. (1991). *JASPER series.* Nashville, TN: Vanderbilt University.

Levine, M. C. (1986). *Science and math activities and resources for teaching home economics (S.M.A.R.T.).* Helena, MT: Montana State Office of the Superintendent of Public Instruction. (ERIC Document Reproduction Service No. ED 275 908)

Lind, M., Williams, A., & Knecht, P. (Eds.). (1987). *Out of this world.* (Project AIMS grades 5-9. Book 9A). Fresno, CA: AIMS Education Foundation. (ERIC Document Reproduction Service No. ED 283 708)

Lomon, E. L., Beck, B., & Arbetter, C. C. (1975, January). Real problem solving in USMES: Interdisciplinary education and much more. *School Science and Mathematics, 75*(1), 53-64.

Maley, D. (1987, May/June). Integrating math and science into technology education. *The Technology Teacher, 46*(8), 9-12.

Manfre, E. (1977). *Classroom design - USMES teacher resource book* (2nd ed.). Newton, MA: Education Development Center. (ERIC Document Reproduction Service No. ED 220 301)

Manfre, E., & Donahoe, C. (1977). *USMES design lab manual* (5th ed.). Newton, MA: Education Development Center. (ERIC Document Reproduction Service No. ED 220 298)

Manos, H. (1972, October). Combining mathematics and physics in high school. *The Physics Teacher, 10*(7), 385-389.

Memphis State University. (1987). *Project WILD: Aquatic education activity guide*. Memphis, TN: Tennessee Administrative Software Clearinghouse. (ERIC Document Reproduction Service No. ED 289 700)

Muckey, R., Rochat, T., & Lundin, S. C. (1971). *Curves and shapes: MINNEMAST coordinated mathematics-science series, unit 2*. Minneapolis, MN: Minnesota University, Minnesota School Mathematics and Science Center. (ERIC Document Reproduction Service No. ED 127 170)

Nuffield Mathematics Project. (1967). *I do, and I understand*. New York: John Wiley.

Nuffield "science uses mathematics" continuation project. (1976, January). *Education in Science, 66*, 17-18. (ERIC Document Reproduction Service No. EJ 139 869)

Ost, D. H., & Webb, L. F. (1973, November). Teaching strategies for the unification of elementary school science and mathematics: A model. *School Science and Mathematics, 73*(8), 670-674.

Our town integrated studies: A resource. (1987). Andover, MA: Regional Laboratory for Educational Improvement of the Northeast and Islands. (ERIC Document Reproduction Service No. ED 298 054)

Page, L. M., & Reed, E. W. (1971). *Using our senses: MINNEMAST coordinated mathematics-science series, unit 4*. Minneapolis, MN: Minnesota University, Minnesota School Mathematics and Science Center. (ERIC Document Reproduction Service No. ED 127 172)

Page, L. M., & Reed, E. W. (1971). *Watching and wondering: MINNEMAST coordinated mathematics-science series, unit 1*. Minneapolis, MN: Minnesota University, Minnesota School Mathematics and Science Center. (ERIC Document Reproduction Service No. ED 127 169)

Preparing people for USMES. An implementation resource book. (1975). Newton, MA: Education Development Center. (ERIC Document Reproduction Service No. ED 220 336)

Project learning tree. A program of the American Forest Foundation. (1987). Washington, DC: American Forest Foundation. (ERIC Document Reproduction Service No. ED 290 612)

Rappaport, D. (1970). Environmental mathematics. *School Science and Mathematics, 70*(6), 515-521.

Rassmussen, D. (1964). SAM — A correlated sequence in science and mathematics. *The Science Teacher, 31*(3), 36-39.

Rogerson, A. (Ed.). (1978). *Co-operation between science teachers and mathematics teachers. Volumes 1-6.* Paris, France: International Council of Scientific Unions. (ERIC Document Reproduction Service No. ED 215 867)

Rowe, M. B. (1988). *Science helper K-8.* [CD-ROM data base]. Gainesville, FL: University of Florida, Knowledge Utilization Project in Science.

Sampson, S. S. (1977). *Design lab design - USMES teacher resource book* (2nd ed.). Newton, MA: Education Development Center. (ERIC Document Reproduction Service No. ED 220 305)

Sampson, S. S. (1977). *Mass communication - USMES teacher resource book* (2nd ed.). Newton, MA: Education Development Center. (ERIC Document Reproduction Service No. ED 220 311)

Sampson, S. S. (1977). *Ways to learn/teach - USMES teacher resource book* (3rd ed.). Newton, MA: Education Development Center. (ERIC Document Reproduction Service No. ED 220 323)

Sampson, S. S., & Agro, S. (1977). *School supplies - USMES teacher resource book* (2nd ed.). Newton, MA: Education Development Center. (ERIC Document Reproduction Service No. ED 220 318)

Sampson, S. S., Finstein, L. A., & Keskulla, J. (1976). *Consumer research - USMES teacher resource book* (2nd ed.). Newton, MA: Education Development Center. (ERIC Document Reproduction Service No. ED 220 303)

Sands, F. (1980). *Tools of oceanography. Ocean related curriculum activities.* Seattle, WA: Pacific Science Center. (ERIC Document Reproduction Service No. ED 289 685)

Schoenfeld, A. H., & others. (1980). *UMAP modules - Units 203-211, 215-216, 231-232.* Newton, MA: Education Development Center. (ERIC Document Reproduction Service No. ED 214 787)

Sneider, C. L. (1986). *Earth, moon, and stars. Teacher's guide.* Berkeley, CA: Lawrence Hall of Science Great Explorations in Math and Science (GEMS).

Sneider, C. L. (1988). *More than magnifiers.* Berkeley, CA: Lawrence Hall of Science Great Explorations in Math and Science (GEMS).

Sneider, C. L., & Barber, J. (1987). *Paper towel testing. Teacher's guide.* Berkeley, CA: Lawrence Hall of Science Great Explorations in Math and Science (GEMS).

Sohre, B. (Ed.). (1971). *Parts and pieces: MINNEMAST coordinated mathematics-science series, unit 22.* Minneapolis, MN: Minnesota University, Minnesota School Mathematics and Science Center. (ERIC Document Reproduction Service No. ED 127 190)

Sohre, B. (Ed.). (1971). *What are things made of? MINNEMAST coordinated mathematics-science series, unit 26.* Minneapolis, MN: Minnesota University, Minnesota School Mathematics and Science Center. (ERIC Document Reproduction Service No. ED 127 194)

Spector, B. S., & Phillips, E. R. (1989, January). Excellence in graduate education for mathematics and science teachers: A sciematics approach. *School Science and Mathematics, 89*(1), 40-48.

Stage, E., Thier, H., Cossey, R., & Karplus, R. (1987). *Quadice.* Berkeley, CA: Lawrence Hall of Science Great Explorations in Math and Science (GEMS).

Stalker, G. H., Arbetter, C. C., Cooper, D. S., Weitzel, F. D., Weiner, N. G., & Gentile, P. A. (1978). *USMES school study: Effects of school strategies on USMES utilization.* Washington, DC: National Science Foundation. (ERIC Document Reproduction Service No. ED 164 355)

Subarsky, Z., Reed, E. W., Landin, E. R., & Klaits, B. G. (1969). *Living things in field and classroom: A MINNEMAST handbook for teachers of early elementary grades.* Minneapolis, MN: Minnesota University, Minnesota School Mathematics and Science Center. (ERIC Document Reproduction Service No. ED 127 166)

Training teachers on-site: The spring semester 1974 at Sanostee and Toadlena. Navajo reading study progress report no. 25. (1974). Alberquerque, NM: New Mexico University, Navajo Reading Study. (ERIC Document Reproduction Service No. ED 127 068)

Unified science and mathematics for elementary schools (USMES) "how to" design lab tech cards. (1972). Newton, MA: Unified Science and Mathematics for Elementary Schools. (ERIC Document Reproduction Service No. ED 183 367)

USMES background papers (unified science and mathematics for elementary schools). (1975). Newton, MA: Education Development Center. (ERIC Document Reproduction Service No. ED 176 996)

Vocational development in grades seven, eight, and nine. A resource guide integrating selected vocational development concepts with eight areas of the curriculum in grades seven, eight, and nine. (1972). Beacon, NY and Albany, NY: Mid-Hudson Career Development and Information Center, Mid-Hudson Industrial Association, New York State Department of Labor, and New York State Education Department. (ERIC Document Reproduction Service No. ED 065 666)

Vogt, E. E. (Ed.). (1971). *Comparing changes: MINNEMAST coordinated mathematics- science series, unit 19.* Minneapolis, MN: Minnesota University, Minnesota School Mathematics and Science Center. (ERIC Document Reproduction Service No. ED 127 187)

Vogt, E. E. (Ed.). (1971). *Conditions affecting life: MINNEMAST coordinated mathematics-science series, unit 23.* Minneapolis, MN: Minnesota University, Minnesota School Mathematics and Science Center. (ERIC Document Reproduction Service No. ED 127 191)

Vogt, E. E. (Ed.). (1971). *Numbers and measuring, learning with TRO: MINNEMAST coordinated mathematics-science series, unit 16.* Minneapolis, MN: Minnesota University, Minnesota School Mathematics and Science Center. (ERIC Document Reproduction Service No. ED 127 184)

Wiebe, A. (Ed.). (1990). *Finding your bearings. Grades 4-9.* Fresno, CA: AIMS Education Foundation.

Wiebe, A., & Ecklund, L. (Eds.). (1986). *Math + science. A solution. Introductory investigations. Book 1.* Fresno, CA: AIMS Education Foundation. (ERIC Document Reproduction Service No. ED 283 700)

Wiebe, A., & Ecklund, L. (Eds.). (1987). *The sky's the limit! With math and science. Aerodynamics. Book 2.* Fresno, CA: AIMS Education Foundation. (ERIC Document Reproduction Service No. ED 283 701)

Wiebe, A., Ecklund, L., & Hillen, J. (Eds.). (1986). *Hardhatting in a geo-world. 3-4 Book B.* Fresno, CA: AIMS Education Foundation. (ERIC Document Reproduction Service No. ED 283 694)

Wiebe, A., Ecklund, L., & Hillen, J. (Eds.). (1986). *Overhead and underfoot. Book D Grades 3-4.* Fresno, CA: AIMS Education Foundation. (ERIC Document Reproduction Service No. ED 283 696)

Wiebe, A., Ecklund, L., & Hillen, J. (Eds.). (1987). *Glide into winter with math and science. K-1. Book 2.* Fresno, CA: AIMS Education Foundation. (ERIC Document Reproduction Service No. ED 283 689)

Wiebe, A., Ecklund, L., & Hillen, J. (Eds.). (1987). *Jaw breakers and heart thumpers. A study in fun foods and body basics. 3-4. Book A.* Fresno, CA: AIMS Education Foundation. (ERIC Document Reproduction Service No. ED 283 693)

Wiebe, A., Ecklund, L., & Hillen, J. (Eds.). (1987). *Popping with power. Book C. Grades 3-4.* Fresno, CA: AIMS Education Foundation. (ERIC Document Reproduction Service No. ED 283 695)

Wiebe, A., Ecklund, L., & Hillen, J. (Eds.). (1987). *Seasoning math and science: Fall & winter. Second grade. Book A.* Fresno, CA: AIMS Education Foundation. (ERIC Document Reproduction Service No. ED 283 691)

Wiebe, A., Ecklund, L., & Hillen, J. (Eds.). (1987). *Seasoning math and science. Spring & summer. Second grade. Book B.* Fresno, CA: AIMS Education Foundation. (ERIC Document Reproduction Service No. ED 283 692)

Wiebe, A., Ecklund, L., & Hillen, J. (Eds.). (1987). *Spring into math and science. K-1. Book 3.* Fresno, CA: AIMS Education Foundation. (ERIC Document Reproduction Service No. ED 283 690)

Wiebe, A., Ecklund, L., & Mercier, S. (Eds.). (1986). *Down to earth solutions for math + science. Earth science. Book 6.* Fresno, CA: AIMS Education Foundation. (ERIC Document Reproduction Service No. ED 283 705)

Wiebe, A., Ecklund, L., & Mercier, S. (Eds.). (1986). *From head to toe. Respiratory, circulatory and skeletal systems. Book 3.* Fresno, CA: AIMS Education Foundation. (ERIC Document Reproduction Service No. ED 283 702)

Wiebe, A., Ecklund, L., & Mercier, S. (Eds.). (1987). *Floaters and sinkers. Solutions for math and science. Densities and volumes. Book 5.* Fresno, CA: AIMS Education Foundation. (ERIC Document Reproduction Service No. ED 283 704)

Wiebe, A., Ecklund, L., & Mercier, S. (Eds.). (1987). *Our wonderful world. Solutions for math + science. Environmental studies. Book 7.* Fresno, CA: AIMS Education Foundation. (ERIC Document Reproduction Service No. ED 283 706)

Wiebe, A., Ecklund, L., Mercier, S., & Buffington, K. (Eds.). (1987). *Fun with foods. A recipe for math + science. Book 4.* Fresno, CA: AIMS Education Foundation. (ERIC Document Reproduction Service No. ED 283 703)

Wiebe, A., Hillen, J., Youngs, D., & Sutton, K. (Eds.). (1987). *Primarily bears. A collection of elementary activities. Book 1.* Fresno, CA: AIMS Education Foundation.

Winkleman, G. (Ed.). (1991). *Mostly magnets. Grades 2-8.* Fresno, CA: AIMS Education Foundation.

Youngs, D. (Ed.). (1990). *Soap films and bubbles. Grades 4-9.* Fresno, CA: AIMS Education Foundation.

Curriculum–Evaluation

Arbetter, C. C., Cooper, D. S., Stalker, G. H., Weitzel, F. D., Weiner, N. G., & Gentile, P. A. (1977). *USMES team study: Using resource teams to disseminate and implement USMES.* Newton, MA: Education Development Center. (ERIC Document Reproduction Service No. ED 164 357)

Arbetter, C. C., Cooper, D. S., Stalker, G. H., Weitzel, F. D., Weiner, N. G., & Gentile, P. A. (1978). *USMES student study: Effects of USMES on student problem-solving abilities and attitudes.* Newton, MA: Education Development Center. (ERIC Document Reproduction Service No. ED 164 356)

Calandra, A. (1959). *A project in the teaching and development of an integrated physics- algebra course at the ninth grade level.* St. Louis, MO: Washington University under Co-operative Research Project No. 403 (7672), of the Office of Education, U.S. Department of Health, Education, and Welfare.

Goldberg, H., & Wagreich, P. (1991). A model integrated mathematics science program for the elementary school. *International Journal of Educational Research, 14*(2), 193-214.

Goldberg, H., & Wagreich, P. (1991). Teaching integrated math and science: A curriculum and staff development project for the elementary school. *Proceedings of the 1988 American Mathematical Society, 1*, 63-129.

Hardy, C. N. (1968, June). *Integration of mathematics and science curriculum. Final report.* Washington, DC: Office of Education Bureau of Research (DHEW). (ERIC Document Reproduction Service No. ED 032 232)

Shainline, M. (1987). *Program to integrate math and science: Evaluation report.* Albuquerque, NM: Albuquerque Public Schools. (ERIC Document Reproduction Service No. ED 384 688)

Shann, M. H. (1975). *An evaluation of unified science and mathematics for elementary schools (USMES) during the 1973-74 school year.* Boston, MA: Boston University. (ERIC Document Reproduction Service No. ED 135 861)

Shann, M. H. (1977). Evaluation of an interdisciplinary, problem solving curriculum in elementary science and mathematics. *Science Education, 61*(4), 491-502.

Shann, M. H., Reali, N. C., Bender, H., Aiello, T., & Hench, L. (1975). *Student effects of an interdisciplinary curriculum for real problem solving: The 1974-75 USMES evaluation. Final report.* Boston, MA: Boston University. (ERIC Document Reproduction Service No. ED 135 864)

Shann, M. H., Reali, N. C., Bender, H., Aiello, T., & Hench, L. (1975). *Student effects of an interdisciplinary curriculum for real problem solving: The 1974-75 USMES evaluation. Summary of final report.* Boston, MA: Boston University. (ERIC Document Reproduction Service No. ED 132 184)

Shoresman, P. B. (1976, November). *Project on elementary school mathematics and science. Final report.* Washington, DC: National Science Foundation. (ERIC Document Reproduction Service No. ED 137 134)

White, E. P. (1976). *The relationship between selected characteristics of regional USMES resource teams to differences in levels of the USMES program.* Newton, MA: Education Development Center. (ERIC Document Reproduction Service No. ED 180 748)